JANUARY, 1957

WORLD OIL

SPECIALIZED FOR EXPLORATION, DRILLING, PRODUCING OPERATIONS AND MANAGEMENT

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Special Report On Corrosion

See Page 3

Dangers of Mid-East Crisis Can Broaden

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SCIENCE LIBRARY

When you make your derrick man reach out and wrestle the elevator with every stand of pipe, you are wasting drilling time and money . . . and sacrificing safety.

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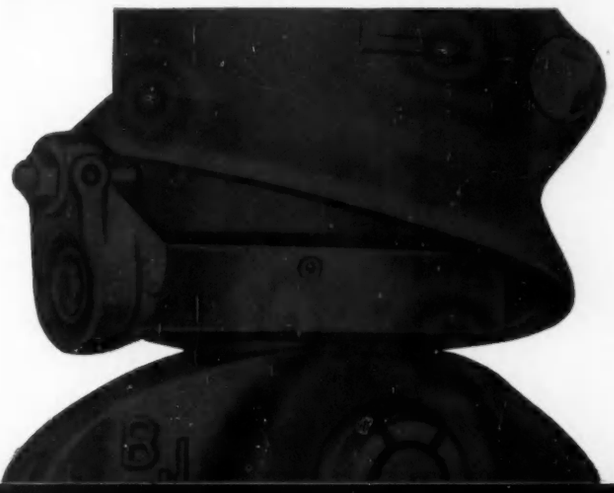

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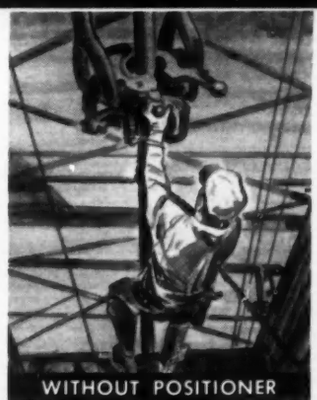
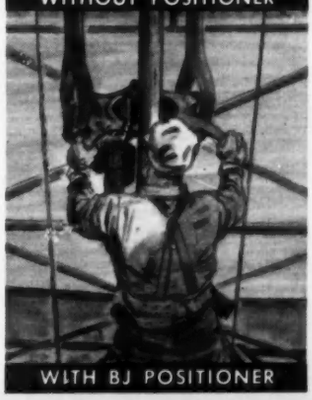


WITHOUT POSITIONER



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THIS MONTH . . .

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WORLD OIL

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a quick look at WORLD OIL this month

BUSY OIL MEN: To help you put first things first, scan these time-saving digests on this and the following pages, checking ☑ those you want to read first.

Special Report

ON CORROSION

THE PROBLEM OF CORROSION to surface and subsurface equipment in both drilling and production activities poses one of the industry's major problems. Because of the magnitude of this problem WORLD OIL has assembled a group of articles dealing with the effect and control of various types of corrosion on oil field structures and equipment. Some of the more prominent methods of combating this corrosion are included in this report. These articles appear in both the Drilling and Production sections of this issue.

☐ **HOW TO SELECT PROTECTIVE COATINGS** for a given application, and what to expect when this coating is exposed under various conditions is outlined in the article beginning on **Page 121.** The advantages, disadvantages, and methods of application for a series of protective coatings are given in **How to Paint a Drilling Rig** ... **John W. Nee**

Turn the Page ➧

THIS MONTH . . .

THIS MONTH . . .

☐ **THE USE OF MONEL,** a nickel-copper alloy, for "splash-zone" protection on drilling structures is discussed in the article beginning on **Page 125.** Salt water presents an intense corrosion problem especially in the area above the low tide mark. How this problem can be met is outlined in the article **Splash Zone Protection for Offshore Structures**.....**Byron B. Morton**

☐ **CATHODIC PROTECTION** has come of age in offshore drilling operations. Internal and external surfaces of submersible hulls must be protected against salt water corrosion. This calls for a protection system that is presently running between 3 and 4 cents per square foot of surface per year. To see how these systems are designed and how they are installed, turn to **Page 129** and read **Mobile Platforms Get Cathodic Protection**.....**By E. P. Doremus and J. G. Davis**

☐ **ZINC COVERING** by galvanizing, low temperature application, and coating is being used to protect drilling equipment on offshore operations as outlined in the article beginning on **Page 136.** Normal application of primer and paint will not protect drilling equipment subjected to the corrosive effects of salt air and salt spray. For a description of the processes involved in protecting the large draw works used in offshore operations read **Painting Isn't Enough on Offshore Rigs** .....**John N. Schuelke**

☐ **CORROSION IN PUMPING WELLS** is one of the petroleum industry's top production problems. Here is a simple explanation of the electrolytic, galvanic and chemical reactions taking place in your well. It may help you to understand the problem more fully. See **Page 157, What Causes Corrosion in Pumping Wells?** .....**Paul Menaul**

☐ **PROPER APPLICATION OF MAGNESIUM ANODES,** including cost figures, current requirements and installation procedures are covered concisely in this presentation. The increased use of sacrificial anodes as a means of controlling corrosion makes this a timely article. Turn to **Page 160. How Magnesium Anodes Retard Corrosion**.....**Hugh A. Brady**

☐ **TAKE A CLOSE LOOK** at external casing corrosion. What causes it? What are its effects? How good is cathodic protection in retarding it? You will find the answers to these questions in the article starting on **Page 163. External Casing Corrosion: Cause, Effect and Control** .....**J. D. Sudbury**

☐ **DON'T WASTE PRODUCING TIME** circulating an inhibitor if you don't have to. Some operators in Kansas are using a heavy, water-dispersible, oil-soluble inhibitor that eliminates the need for circulating the well. Pumper's time and shutdown time are reduced, which means a profit for the operator. For details see **Page 174. How to Stop Corrosion, But Not Production**
E. G. Stevens

CURRENT OUTLOOK

☐ **In order to meet U. S. future oil needs,** American operators probably will have to import substantial quantities of oil in addition to expanding domestic production. It is essential for them to develop new reserves abroad as well as at home. The countries where they can confidently seek and develop new reserves are comparatively few. It is necessary that American operators actively try to promote acceptance and protection of free enterprise oil development in additional countries. To do this needed work it is suggested that an industry agency or committee be set up. It is further suggested that the agency be established by the American Petroleum Institute. See **Page 80. Industry Agency Should Promote U. S. Oil Development Abroad** .....**Henry Carter Rea**

☐ **Cooperation between lawyer and petroleum engineer** is essential for solving many problems in the oil industry. Together they can promote favorable legislation and devise sound operating plans. Their joint efforts are needed in preparing lease and drilling contracts. The knowledge of both is required in connection with proper well spacing, unitization, and other operating matters. See **Page 83. Lawyer and Engineer Solve Oil Problems** .....**C. H. Keplinger**

☐ **The oil industry has taken the lead** in using modern research methods to improve employe efficiency and obtain more harmonious employe relations. The industry's most successful research tools to date are "background" research to get the facts and "direct" research to find a common factor in comparable situations. For an expert's views on oil industry progress in this vitally important field, turn to **Page 85. Human Relations—A New Use for Research**....**E. L. K. Frost.**

☐ **You don't have to be an Einstein** to think creatively. You only have to apply a few simple psychological laws. For a thought-provoking discussion of the four basic steps to creative thinking, plus a sound plan tailor-made to help you make profitable use of "brainstorming" sessions, see **Page 88. Creative Thinking Can Pay**.....**Charles H. Clark**

☐ **Despite some obvious shortcomings,** the U. S. oil industry has done a tremendous job of meeting the challenge presented by Western Europe's urgent need for oil. In this exclusive WORLD OIL report you will find a complete analysis of the problems involved in moving enough crude to the Gulf Coast to meet the phenomenal rise in export demand—the plan for routing crude to the Gulf and to Europe—actions taken by pipe line companies to meet the emergency—plus, the latest Interior Department figures on pipe line capacity, ultimate goals for crude movement and oil shipments from the Gulf to the East Coast and Western Europe. For the full report, read. **Suez Crisis Puts Pressure on U. S. Pipe Lines** .....**Page 94**

WORLD OIL, published every month except semi-monthly in February and August. Entered as THE OIL WEEKLY as second class mail matter December 23, 1916, at postoffice at Houston, Texas, under the act of March 3, 1879.

THIS MONTH . . .

☐ **If all of oil's contributions** to the American way of life were known—and understood—by the non-industry public, we would have no need to worry about support when the chips are down. As oil industry representatives, **you** must let the public know what the true facts are. So that every employe in the oil industry will have an opportunity to know oil's story, WORLD OIL presents the second of its series **If Oil Could Speak** on **Page 100.** You will find these unusual true facts are tailor-made to help you become a better public relations ambassador for your industry. **Look for the little oil man—who can't speak.**

☐ **Higher U. S. crude oil prices** may result from increased shipments to Western Europe as replacement for Middle East oil shutoff because of the blockage of the Suez Canal. The crude situation in the U. S. has become very tight. Despite increased production, extremely large drafts have been made on crude inventories in recent weeks. There is a demand for more oil to export to Europe than can be delivered to Gulf Coast ports by present pipe line facilities. The biggest question is whether higher postings could be maintained when the Suez Canal is reopened to Middle East Oil. **U. S. Crude Prices May Be Advanced . . . . . Page 102**

EXPLORATION ARTICLES

☐ **Whether searching for oil or uranium**, similar exploratory methods can be used. Here is an article discussing the lithologic, structural, and mineralogic characteristics of typical sedimentary uranium deposits in the western U. S. The object of the search is thus defined and the means by which this search may fit into petroleum exploration operations is discussed in terms of geologic, geophysical and physical exploration methods. Turn to **Page 111. Uranium Exploration Methods Offer Advantages in Petroleum Finding.**

Jack Kratchman

☐ **A new and useful tool in the industry** is the use of contact logs in conjunction with sidewall cores to determine porosity. Case histories are proving this. Beginning on **Page 115** is an analysis of this technique and a comparison of the results with other methods. **Logs and Cores Indicate Porosity.**

C. R. Miller Jr., and C. B. Evans

OTHER DRILLING AND PRODUCTION ARTICLES

☐ **Proper analysis of dull bit condition** will enable the driller to make a proper selection of the next bit and thus improve bit performance. A chart of the more common appearing dull bits is presented on **Page 139. Study Your Dull Bits . . . . . H. G. Bentson**

☐ **In a novel adaption of diesel electric rigs** to portable rigs a major company has just received a rig that combines the portability of trailer-mounted rigs with the flexibility of operation of the diesel electric rig. This is a unique experiment to trim the size and weight of diesel electrics down to the 7000-foot class rigs. To see how this rig was assembled, read **Diesel Electric Rigs Are Going Portable . . . . . Page 146**

☐ **Would a 100 billion-barrel untapped oil reserve interest you?** There is at least that much in Colorado's oil shale. With discovery and production costs rising constantly, it won't be long before someone starts mining oil at a profit. See **Page 177** and Part 2 of the article **Don't Overlook Oil Shale . . Earl Trager**

INTERNATIONAL ARTICLES

☐ **Made mindful of its precarious oil supply line** because of the Suez dispute, will Western Europe—faced with rationing and short supplies of oil this winter—consider turning again to a more certain coal supply at the expense of further growth in oil use? For a consideration of this possibility, and others, turn to **Page 191. Will Western Europe Reappraise Value of Oil? . . . . . Don Kliewer**

☐ **Austria has regained control of its petroleum industry.** But her problems have not ended. For a detailed analysis of what may happen to properties formerly owned by western oil companies, the possibility of outright nationalization, the value of Austria's oil and gas fields, as well as the political events which have laden the industry with problems, read **Austria Tries to Unravel Tangle of Foreign Control . . Page 193**

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You'll Find the Answers In Your Feb. 15th WORLD OIL

The MIDDLE EAST impact on oil industry operations has created an even greater need for factual information on future oil demands.

Right now, U. S. oil is moving fast to bolster rapidly dwindling European stocks . . . with top oil men seeking dependable data that will reveal what to expect . . . indicate how to plan.

You'll find answers to important questions about 1957 oil activities in WORLD OIL's Special FORECAST-REVIEW Issue which will be off the press February 15. This special issue will provide you with the information you can use to plan more effectively . . . prepare important reports . . . compare your '57 program with the rest of the industry. The reliability of WORLD OIL's forecasts is known throughout the industry. Over the years, they have been within 95 percent accuracy (and some years only one percent off!).

Here are just a few of the important questions you'll find answers to in the Special 1957 FORECAST-REVIEW Issue:

- **What are the prospects for oil demand in 1957?**
- **What are the prospects for oil prices?**
- **How much oil will the U. S. be called on to produce in 1957?**
- **How will oil imports and exports be affected?**

In preparing this Special Issue, thousands of sources have to be checked . . . analyzed . . . and reviewed by staff and industry experts. Every item in the FORECAST-REVIEW Issue is aimed to give you the thinking of the best minds in the industry.

Also . . . you'll have a ready reference to complete yearly statistical trends from as far back as 1859—something you won't find anywhere else.

Your Special 1957 FORECAST-REVIEW Issue will serve as a factual source of information you can use the year 'round. So . . . be on the lookout for it.

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PIPE LINE INDUSTRY and THE PIPE LINE COMPOSITE CATALOG (first edition to be issued in July, 1957) for the oil and gas pipe line industry.

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Indexed by Industrial Arts Index Engineering Index

Looking Ahead . . .

General Business Outlook Clouded . . . Business forecasters have to peer through clouds and fog to try to foresee what lies ahead in 1957. There is no clear view of more booming conditions such as those of 1955 and 1956. A few lines expect improvement of business, particularly the automobile and shipbuilding industries. But in general, there is mostly cautious optimism.

Several things threaten to hold down activity to levels little or no higher than those of 1956. They include the troubled international scene; the tightness of money; and the prospect that higher costs will boost prices, reduce demand, and slow business, or else squeeze profits and postpone some business expansion. It appears that 1957 will be a year of good but not booming business.

•

Oil Industry Expects Gains . . . The petroleum industry may fare relatively better than some other lines and business in general. The industry has the traditional advantage of ever-increasing demand for its products.

Petroleum economists and executives are expecting domestic demand for oils to show in 1957 the normal increase of 4 to 5 percent. Exports should average at least as much as in 1956 and possibly more because of the temporary emergency shipments to Western Europe.

U. S. crude production in 1957 is expected to average at least 3 percent more than in 1956. Crude runs to stills will rise more than 3 percent, it is estimated. Production of natural gas and natural gas liquids should increase substantially, as heretofore.

•

Western Europe to Be Set Back . . . It is hoped that Western Europe can be provided with up to 80 percent of normal oil requirements from the Western Hemisphere as long as the regular movement from the Middle East remains disrupted. There is optimism that the Suez Canal may be cleared and sabotaged pipe lines be repaired in fewer months than originally expected.

Dollar shortages may soon become a more serious limitation on European oil imports than availability of the oil. Even under the best conditions to be expected, Western Europe will have had a serious economic setback.

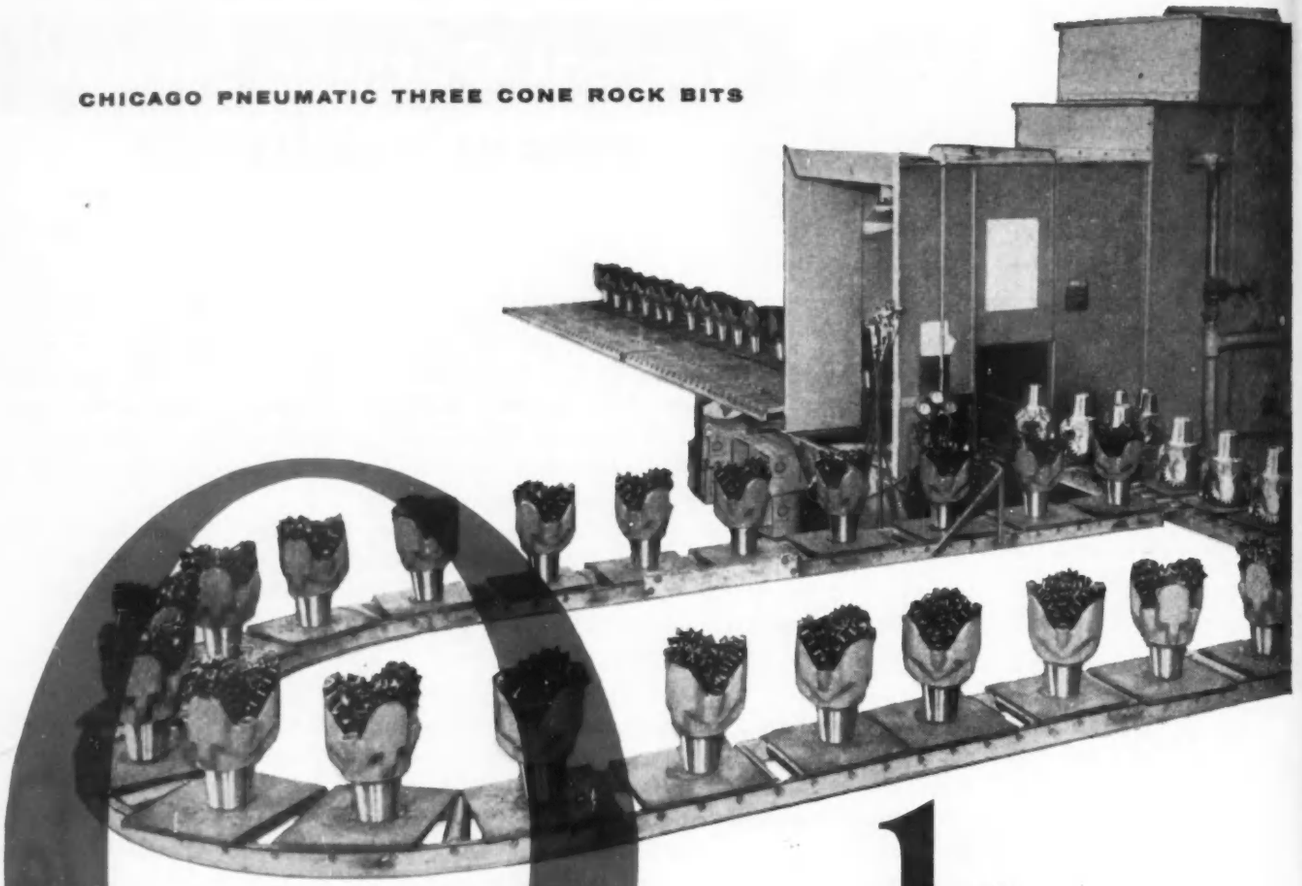
•

Western Hemisphere Will Feel Ill Effects . . . The U. S. and other Western Hemisphere countries are certain to feel some ill effects from Western Europe's business slowdown due to shortage of oil. If the European let-down lasts very long, the effects on the Western Hemisphere may grow serious.

Decline of international trade would affect many American businesses, retarding exports of manufactured goods and imports of raw materials. Economic weakening of Western European allies would jeopardize America's security. The U. S. could not afford to see collapse of Western European economies, even if U. S. financial aid to those countries had to be greatly increased.

Oil Use to Rise in U. S. but Drop in Europe . . . R. G. Follis, chairman of Standard Oil Company of California, predicted a 6 percent increase in petroleum demand in the U. S. during 1957. In the absence of the current Suez crisis he would have predicted a 13 percent increase in demand in Europe, as compared with a 15 percent rise during the first 10 months of 1956. But with severe rationing imminent in

CHICAGO PNEUMATIC THREE CONE ROCK BITS



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Europe, European demand is expected to *decrease* by 5 to 10 percent during the first six months of 1957 if not for a longer period.

Notwithstanding Middle East complications, Follis expects continuation of a basic long term growth of world petroleum consumption. Further large scale capital expenditures by the industry consequently will be required. Spending will be heavy particularly for exploration and development of crude oil resources, he predicted.

•

Industry Faces Three Major Problems . . . In going into 1957 the petroleum industry faces three major economic problems, stated L. F. McCollum, president of Continental Oil Company. First is the problem of working off the large gasoline inventories which accumulated in 1956.

Second is the need for careful handling of operations in meeting the current emergency oil needs of Western Europe. Europe needs primarily crude oil, distillates, and residual fuel oil and not gasoline. To meet European needs, there should be further withdrawals of crude from storage, particularly in inland areas, before domestic crude production is materially increased.

The third problem faced is the need for higher crude prices to cover rising oil finding and development costs. McCollum expressed hope that a general crude raise may come soon, in view of the world-wide crude shortage caused by the Middle East situation.

•

Steel Tubular Goods Will Remain Scarce . . . The outlook for steel tubular products continues tight. Pipe for the oil industry will certainly be in short supply through the first half of 1957, at least. The effects of last summer's steel strike are still being felt. The growing demand for steel plate for new tankers because of the Suez Canal blocking is cutting into the plate supply for welded pipe. In turn, there will be additional pressure on the supply situation for seamless tubulars.

•

Higher Wages and More Fringe Benefits Sought . . . Basic wage increases of 27 cents an hour and increases in fringe benefits will be sought in the early future by units of the Oil, Chemical and Atomic Workers' Union. Present wages start around $2.56 an hour. Oil companies last granted general wage increases effective February 1, 1956. They amounted to 6 percent, with a minimum boost of 15 cents an hour. Many contracts will come up for renewal within the next few weeks and a majority by early spring.

Mexico Plans Expansion of Drilling . . . Increased drilling and development are projected for 1957 by Mexico's government-operated oil company, Petroleos Mexicanos. Expansion will be based on increasing domestic consumption and good export markets created by the Suez situation. Over 400 wells will be drilled. Pemex lately acquired 20 new rigs and now operates 110, compared with 88 a year ago. During the past year 18 new fields were discovered, including several that appear quite important.

Mexico's principal oil problem is the need for expanding refining and pipe line capacity. The country imported over 15 million barrels of refined products in 1956. That was a heavy drain on Mexico's dollars. The government maintains low prices on petroleum products. Consequently, there is inadequate incentive for investment of capital in refining facilities.

•

More Offshore Surveys Scheduled . . . During the past three years, the Bureau of Land Management of the Department of the Interior has mapped about 21 million acres of submerged land on the Outer Continental Shelf in the Gulf of Mexico. New areas will shortly be undergoing cadastral survey off California. Up to November 30, 1956, the U. S. Treasury had received an income of more than $252 million from offshore oil and gas leases.

Good Wells Make Good News

Many operators are getting quick payout from Petrojel*. Since Petrojel makes use of the operator's own lease crude (gelled) as the fracturing fluid, treatment costs are low. Payouts have been correspondingly fast. Kerosene or diesel fuel may be used when lease crude is not available. Here are examples from different fields.

- ***Wise County, North Texas***—(New well) Completed in 60-foot, three-zone section of Strawn sand at 4,000 feet. Permeability estimated at 10-15 millidarcys. Swabbed only four barrels of oil per day. Treated with Petrojel using 15,000 gallons of fluid plus F.L.A.* (Fluid Loss Additive) and 15,000 pounds of sand—through tubing in three stages using straddle packers. After 60 days, well tested 80 barrels of oil per day. At 40 barrels of oil per day allowable, treatment cost of $1,455 paid out in 21 producing days.

- ***Colorado County, Texas Gulf Coast***—(Old gas well) Completed in Wilcox sand with perforations from 9,320 to 9,378 feet. Bottom-hole pressure-buildup test on this well indicated that a "skin effect" around the hole was holding potential to 6,900,000 cubic feet per day. The well was given a 250-gallon spearhead of Mud Acid. Then it was treated with Petrojel, using 6,000 gallons of fluid with 9,000 pounds of sand. Two months later, well was producing 13,000,000 cubic feet per day and open flow potential was 72,000,000.

- ***Southeastern Saskatchewan, Canada***—(New well, discovery) Completed in Mississippian Charles. Perforated from 5,983-5,990 feet the well had been acidized twice, yet production was only 40 barrels of oil per day. Dowell fractured through tubing with Petrojel, using 5,000 gallons of gelled diesel fuel and 8,000 pounds of sand. After $1,700 treatment, well tested 90 bopd.

- ***Barber County, Kansas***—(New well, gas) Completed in Mississippian chat of Driftwood pool through perforations from 4,835 to 4,867 feet. After acidizing, well tested 3,500,000 cubic feet per day. Petrojel, using kerosene for quick clean-up, was selected for further stimulation. Treatment used 25,000 gallons fluid with 30,000 pounds of sand and 1,250 pounds fluid loss control agent. Injection rate was 41.4 barrels per minute. After treatment, well potentialed 169,000,000 cubic feet per day.

Whatever treatment is required for your well, you can depend on Dowell—for an unmatched variety of fracturing and acidizing techniques, plus the experience, the research facilities, and the equipment to apply them properly.

For more information or service, call any of the 165 Dowell offices in the United States and Canada; in Venezuela, contact United Oilwell Service. Or write Dowell Incorporated, Tulsa 1, Oklahoma.

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Services for the Oil Industry

DOWELL

A Service Subsidiary of The Dow Chemical Company

Don't Delay Import Solution

Disrupted Middle East shipments provide only a temporary solution to the U. S. oil import problem. Present relief does not offer even a partial permanent solution to this highly serious question.

True, the U. S. oil industry is going to benefit greatly for the time being from increased production to meet the emergency shortage in international markets. Enlarged U. S. production will provide needed relief to producers from stringent proration. Furthermore, currently excessive crude stocks will be reduced.

This is fine for the U. S. producer. However, these benefits will be only temporary. In time, Middle East oil will return to international markets.

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Serious economic conditions will confront the U. S. oil industry when the Middle East emergency is over.

U. S. production and exports will have to be reduced to normal levels. This will not be easy. Drastic cutbacks never are easy, especially when hundreds, even thousands, of different individual and company interests are involved.

The import problem, at the same time, again will face the U. S. Returning Middle East oil shipments and other imports will again bring this question to the forefront. It may well be more serious than experienced previously.

Many factors will increase the pressure to import oil into the U. S. Tanker capacity in operation is being increased. Middle East companies and countries will want to make up some of their lost revenues.

Such conditions will not be conducive to settlement of the import question.

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Now is the time for the U. S. to do something about the import problem. Instead of postponing a decision on import curbs now is the time to work out a solution.

Normal shipping and marketing patterns have already been disrupted by stoppage of Middle East shipments. It would be much easier on Middle East countries and companies, and on U. S. producers too, if they know in advance what conditions will exist at the end of the current emergency. If the U. S. made known its intentions now, everybody concerned would sometime have to take steps that might soften their hardships.

If a definite course of action is postponed until after the Middle East emergency, as Office of Defense Mobilization Director Arthur Flemming has stated it will be, the question will be more difficult to solve than now.

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This is largely the responsibility of Director Flemming. He is the one who must take the initiative in working out a solution. He should not let this opportunity pass without seeing that a definite pattern for future U. S. imports is established.

As stated in a previous editorial (Page 75, WORLD OIL, December, 1956):

"But the subject (imports) is so important that the best brains of the industry—not firebrands on either side—should be called together by our government to work toward a solution of this problem."

There must be a fair apportionment of imports to domestic production if the best interests of the nation and the oil industry are to be served by a healthy U. S. oil industry, which recent world events have demonstrated are absolutely essential to America's national security.

Now is the time to do this. Current conditions are more opportune than in the past or than will exist once the Middle East emergency is over.

Ray L. Dudley

effects of implementation of the laws and at government level to under-

Industry Agency Should Promote U. S.

• American operators need well scattered foreign reserves to supplement domestic supplies.

• Relatively few countries are friendly to free enterprise development of oil.

• It is essential that American operators try to get more countries to accept and protect private oil development.

• To do this work an industry agency or committee is needed, although some companies are making such efforts individually.

• It is suggested that the needed agency should be set up by the American Petroleum Institute.

By HENRY CARTER REA, Denver

IN THE FUTURE the U. S. probably will have to import substantial volumes of oil besides expanding domestic production. American oil companies must vigorously develop new reserves not only at home but also abroad. Development of foreign reserves for American use must be spread widely over the earth to avoid too much dependence on any source.

At present there are only a comparatively few foreign countries where Americans can seek and develop oil reserves with confidence. Only in those countries can Americans be reasonably sure of the sanctity of contracts and lasting rights to any reserves they develop.

It is essential for American operators to try to increase the number of countries where they can confidently undertake oil exploration and development. They must actively promote foreign acceptance and protection of the free enterprise system and private development of oil resources.

Some large American oil companies already are individually trying to convince foreign nations of the advantages of free enterprise in the oil industry. However, there are some prejudices against those efforts, handicapping them. To avoid some of the problems involved in separate, individual efforts, it is here proposed that these activities be consolidated under a central agency or committee of the oil industry. It is further suggested that the agency should be set up by the American Petroleum Institute.

U. S. Needs to Climb. It is estimated that by 1965, 12 to 13 million barrels of oil per day will be required to meet domestic consumption. It is problematical that the U. S. can supply this demand without supplementary imports, if present political and economic conditions persist.

Our ability to find new sources of oil in the U. S. is not questioned. It is not implied that our potential is used up. But existing conditions in the U. S. have made exploration and exploitation for new reserves follow the law of diminishing returns. A slow but certain elimination of the incentive to invest in exploration or development is being caused by several things. Among them are the following:

- The constant and continuing pressure being brought on our legislative and executive branches of government, both federal and local, for more restrictive legislation affecting the oil industry.
- The strong weight of public opinion against a realistic outlook toward a rise in the price of crude oil.
- The continuing fight to reduce or eliminate the depletion allowance.
- A confiscatory tax system.

In view of this existing situation, there is growing concern in the industry regarding America's ability to supply its oil needs in the future from within its own borders.

Bluntly and briefly, we are using up our reserves at below replacement cost.

Oil Availability Limited. The Rocky Mountain region, plagued by a lack of outlets and markets, high operating costs and severe weather conditions, still remains one of our great untapped potential sources of future reserves. The Appalachian region, in the heart of the nation's choicest marketing area, has never been given the geological attention it deserves. And as our ideas on the accumulation of oil grow and change, new and heretofore unconsidered regions begin to show promise. There are good possibilities of future discoveries. But those potential reserves must yet be found and developed.

At present there exists an over supply of crude in some sections, while the West Coast has to depend on imports to meet requirements.

The call for 750,000 to 1 million barrels per day for Western Europe to help her over the present crisis very definitely shows up the weak links in our crude oil distribution system. Because of this weakness it is the Gulf

hearty cooperation of the U. S. De-

act independently to preserve their

Oil Development Abroad

Coast region that will supply the major portion of this demand.

Must Seek Oil at Home and Abroad. In view of the increasing world demand for energy and the constantly shifting patterns for liquid fuels, it becomes mandatory that the American oil industry not only seek new reserves at home but also actively prosecute such a policy abroad. Regardless of a strong minority opposition who have advocated federal legislation to curb all imports of crude oil into the U. S., the search for new world-wide sources of crude and a balanced import policy are obligatory on the oil industry. The aid to Western Europe in her present oil-short position should be handled judiciously, with an eye to our own future mounting requirements.

Few Countries Friendly to Free Enterprise. At present there are only a comparatively few countries outside the U. S. offering possibilities of oil reserves that would be dependable and safeguarded by sanctity of contract. They include the British Commonwealth of Nations, the Belgian colonies of Africa, Venezuela, Turkey, Pakistan, France, and a few others.

The possibilities of American development of new oil reserves abroad have been narrowed down to those countries through the recent seizure of the Suez Canal by Egypt; the sabotage of the Iraq pipe lines; the unilateral abrogation by Indonesia of her treaties and contracts with the Netherlands; the instability and indecisiveness of the Italian Government in passing favorable legislation for the exploitation of recent discoveries; the unfavorable political climate of India, Brazil, Argentina and Chile; the past clouded history of Bolivia, Peru, Guatemala, and Mexico; and the strong anti-western feeling in the Arab countries.

Control of the world's oil has to be in stable hands to promote the peace of the world. Russia, which supplies Iceland, Finland, Sweden, Greece, Israel, and Italy with some or all of their petroleum requirements, could at will shut those countries off, if and when she so desires. Egypt has amply demonstrated what an irresponsible dictator can do to bring Europe to her knees. Indonesia, by the repudiation of her debts to Holland, has indicated that she is not unfamiliar with the process of nationalization.

These current facts make it evident that the American oil industry will have to renew its efforts and take the calculated risks to find new reserves abroad and to so diversify their exploration, development and transportation activities that there can not be another "Suez."

Must Conduct Educational Campaign. The world political picture today looks dark gray, and in some instances black, for the entrance of American capital for the development of oil resources. But this should not be a deterring factor in the active prosecution of an educational campaign in the underdeveloped countries that have nationalistic leanings. Nationalism is a political ideology, and any ideology costs money. Over a period of time the people of any country who are being deprived of the nominal improvements of their nation, compounded by rising economic pressures and inflation from within, are certain to ask, "What price nationalization of our natural resources?"

A campaign, no, a policy, for educating underdeveloped nations to the advantages of our free enterprise system in the oil industry should start with those members of foreign governments at the policy-making level. Those individuals and a small staff of department heads and their own attorneys should visit the U. S., Canada, and Venezuela to study the laws and regulations under which these three successful countries operate their oil industry. This study should be at both industry level to get the effects of implementation of the laws and at government level to understand why such legislation was enacted.

Private Efforts Have Drawbacks. A great deal of this kind of work is being carried on today independently by the international oil companies. This present method of indoctrination of policy-making officials and training of technicians has several drawbacks. The host company is first prejudiced in that it has an interest in the particular country in question. Hence the guests are prone to expect some bias in what they hear and see. The guests will get only one segment of industry thinking and it it will be that of the host company. Further, the technicians who might all be trained by a host company will all return to their homeland with only one approach to a problem, one solution, and one way of doing things, that of the host company.

Industry Agency Proposed. The idea of consolidating these activities under a central agency of the oil industry would bring about a better understanding on the part of foreign officials on how our industry operates. Such an agency or committee would be above the stigma of politics both at home and abroad. Any interested company could act through this agency, in a sense anonymously.

Such an agency should be set up by the API. Already established and having the approbation and respect of the entire industry both at home and abroad, it could more adequately implement such an activity than any newly created organization of interested companies. Further, and of signal importance, the API represents the entire oil industry, not only oil companies seeking new sources of oil, but all of the contributing industries: steel, automotive, electrical, manufacturers and contributing services. These other contributing industries, which actually make exploration and development possible, have a great deal at stake in the world's markets; and they would not only welcome such a proposal, as suggested, but would actively work for it.

The financing of such an agency would be spread over industry instead of being borne by an individual company as it is now. Such an agency of the API would have the active and

hearty cooperation of the U. S. Department of State, as the department has already demonstrated in many cases of foreign visitors.

Government Agency Not Suitable. The International Cooperative Administration (ICA) has done excellent work in some spheres of activity abroad and is to be commended. However, in the U. S. the search for oil is not a government function, and ICA is not equipped to do the job suggested for the American Petroleum Institute. Further, our government is not sufficiently in touch with the oil industry to fully evaluate the problems that are presented in foreign fields. To some extent politically, yes, but economically and scientifically, no. There is also the suspicion on the part of foreign visitors that, regardless of our protestations that our oil industry is not government controlled, we are trying to hide something from them. This writer has personally experienced such situations with foreign visitors.

South America First. If the unsettled political conditions in the Near and Far East continue to deteriorate, and even if they don't, it would be prudent for the American oil industry to concentrate more on South American countries as a future continuing source of new oil. The political situation in some of the countries of the southern hemisphere seems impossible at the moment. But the maintaining of an expensive political ideal in those countries will eventually become too burdensome to continue, particularly when their sister nation of Venezuela is held up for an example.

One man, in one small backward country, Nasser of Egypt, has demonstrated through his irresponsibility that he could change the world pattern of economics, with serious ramifications, and has forced the countries of Western Europe to his will. It consequently behooves the American oil industry to step up its education policy in foreign countries that are not favorably disposed to the entrance of private capital for the development of their petroleum resources. The diversification of sources of supply throughout the world in the future will preclude the repetition of such an action by another "Nasser" at another time and place.

About the Author

HENRY CARTER REA, consulting geologist and petroleum consultant, graduated from the University of California in 1927 with a degree in geology.

He spent subsequent years in geological exploration throughout the U. S. and in Canada, Java, Borneo, India, Afghanistan, Pakistan, Baluchistan, Italy and Holland. In the U. S. he worked in California, Oklahoma, Texas, Kansas, Kentucky, Indiana, Alabama, Mississippi, Colorado, Montana and Wyoming.

For the past 11 years, Rea has been an independent consulting geologist and petroleum consultant in the Rocky Mountain region, headquartered first in Casper, Wyo., and subsequently in Denver.

Now Is the Time. Emphasis on such an educational program at the present time seems imperative for several compelling reasons. The clearing of the Suez Canal is not being prosecuted with utmost vigor. When the Canal is cleared its future will be extremely uncertain. That it will not in the future be depended upon as a vital life line for Western Europe is certain. This then will bring about a definite change in trade patterns of both Europe and Asia.

It is also highly improbable that the present generation will see the end of the Arab-Israeli feud. It will always be a contentious problem. The hatreds of the more backward people of the world lie deep and are not quickly nor easily forgotten.

The policy rift between the U. S., Great Britain, and France over Suez and the Near East could have serious future consequences. This fact alone demonstrates the uncertainty and insecurity of international pacts or agreements. When in their opinion their security is threatened, nations act independently to preserve their entity or economic livelihood.

Too Little and Too Late. Recent European press reports indicate that India has signed a contract to retain 175 Soviet experts to conduct a petroleum exploration program, having appropriated some $65 million (U. S.) for this effort in the present five-year plan; and they will also build a plant in which to construct drilling equipment. India's decision to take this route might be attributed, in part at least, to the famous American policy of "too little and too late." Such a decision as India has recently made regarding the development of her oil potential was based on ignorance of our system. India's Minister of Natural Resources paid a very short visit to the U. S. last September and October. But his schedule was tight, and the time he allotted for the visit was insufficient to actually study the problem. These facts, coupled with a suspicion that India had already decided on her policy before the Minister arrived in the U. S., suggest that the U. S. was definitely too late in its offer of assistance.

India's recent action certainly points up the problem and is sufficient reason for the American oil industry to reconsider its past foreign policy in the light of rapidly changing world developments and increasing demands for energy.

A Representative in Each Country. Under these circumstances it is certainly within the realm of realistic thinking that such an agency of the American Petroleum Institute as has been suggested should have a representative in each of the underdeveloped potential oil countries of the world. The representative would act as an ambassador for the American oil industry and as a liaison contact between government and industry. Company representatives that are stationed abroad cannot adequately do the job because of their company affiliation and interest in the country. They are suspect in the eyes of the local government, and their thinking and consultation with officials is accepted with some prejudice and reservations.

Finally, if the API can represent the American oil industry in the U. S., why can it not do the same in foreign countries? —**The End**

Lawyer and Engineer Solve Oil Problems

About the Author

C. H. KEPLINGER has been engaged in consulting practice for appraisal of oil and gas properties since 1944, entering consulting work after 15 years experience in the oil industry in the Mid-Continent. Keplinger was engaged in production and reservoir engineering work for Shell Oil Company in Kansas and Oklahoma from 1933 to 1944. He received his B.S. degree in physics from the University of Tulsa in 1931. After spending a summer term studying geophysics at Goettingen University, Germany, he received a master's degree in physics at George Washington University in 1933.

• Their cooperation is required in promoting favorable conservation laws and in securing sound regulations.

• Together they can provide sound answers to questions on well spacing, unitization, and other operating matters.

• Their joint efforts are needed in preparing drilling contracts, leases, pooling agreements, and tax data.

By C. H. KEPLINGER,
Keplinger and Wanenmacher, Tulsa

THERE ARE many activities in the oil and gas industry which require the joint cooperation of the lawyer and the petroleum engineer if they are to be done well. A few include:

- Preparation of oil well drilling contracts.
- Preparation of operating lease contracts.
- Preparation of oil and gas reserves for the tax attorneys.
- Study of efficient production rates for oil fields.
- Salt water disposal recommendations and hearings.
- Allocation of oil and gas allowables.
- Pooling agreements for wells.

The petroleum engineer is quite dependent upon the lawyer in order to gain the most from his efforts and particularly in his attempts to obtain the maximum realization from the world's natural oil and gas resources for the benefit of mankind. It is indispensable that the lawyer understands and promulgates straight thinking in dealing with the legislative branches of state, federal and foreign governments. In many instances the engineer may have the solutions to problems worked out. But these solutions cannot be put into effect until favorable public opinion has been generated, through the help of the legal profession. A review of the present status of the conservation laws of the respective states indicates there is much yet to be accomplished. This will come about only through close cooperation between the lawyer and petroleum engineer.

In its highest purpose, petroleum engineering is more than mathematical and physical science applied to development and operation of oil and gas fields. It includes an obligation to be of service to mankind, by increasing the standard of living, and providing more opportunities to a greater number of people. In order to fulfill this important phase of petroleum engineering, it is most necessary that the engineer has the confidence and respect of the lawyer.

UNITIZATION. Through years of observation and scientific investigation the petroleum engineer has come to the conclusion that in many oil and gas fields, conservation, which may be defined as the prevention of waste, and realization of the greatest ultimate recovery of petroleum hydrocarbons, requires that the underground reservoir containing the oil and gas be operated as a unit. This necessitates unitization of all parties owning either working or royalty interests in the oil and gas reservoir to obtain the benefits of sound petroleum engineering.

It is here that the lawyers are needed to study the problem and to provide adequate conservation laws which will allow the operators to apply the most efficient engineering methods. Lawyers have done a grand job in providing adequate conserva-

ing and expanding. It recognizes that

tion laws in many of our states. However there is much work to be done in the future because the engineers through research and field engineering studies are continually developing better conservation plans which the lawyers must interpret and digest for promulgation into new laws.

Lawyers in Oklahoma have provided the state with a comprehensive conservation act and reasonable unitization legislation. Their efforts in the State of Oklahoma have resulted in statutes which provide for compulsory unitization of oil and gas reservoirs.

Progress in conservation involves education of the public so that it understands the engineering principles which lead to the greatest recovery of oil and gas and the advisability of conserving these resources.

Many states have some form of conservation legislation but they are lacking in adequate unitization provisions.

WELL SPACING. Proper conservation laws should include reasonable well spacing regulations. Here, again, is another problem in oil and gas where the lawyer and engineer are closelv related.

During the early development of the oil industry, wells were drilled on a rather dense spacing program. As more information became available it was found that ultimate recovery in a continuous reservoir was independent of well spacing, and that the extra drilling was an economic loss.

From a practical standpoint, pools which were drilled on wider spacing obtained the same recovery as pools drilled on closer spacing. From the theoretical standpoint, the engineering of oil reservoirs indicated that recoverable oil was independent of spacing. After the advent of the bottom-hole pressure gage, interference and intercommunication between wells on spacing patterns of greater than 160 acres was proved.

The leading petroleum technologists in the oil industry are in agreement that recoverable oil from a continuous reservoir under efficient operating conditions is independent of the spacing, which means in practical terms that reservoir continuity is a most important factor in determining a spacing program.

The Interstate Oil Compact Commission, a voluntary organization of oil and gas-producing states dedicated to the conservation of oil and gas, has made comprehensive studies of well spacing, and has reviewed the numerous studies of well-spacing prepared by outstanding petroleum engineers. Its research and coordinating committee presented the results of its investigation on well spacing (I.O.C. C. Quarterly Bulletin, Vol. X, No. 2):

In gas-expansion reservoirs, the original energy potential of the gas is normally much greater than that needed to move oil to wells through great horizontal distances and to raise the oil produced in the early life of a pool to the surface after it reaches well bores.

Energy available for moving oil to wells in water-drive fields is limited only by time and is not qualified by distance of horizontal movement.

In fields with both gas-expansion and water-drive energy, production should be controlled to make maximum use of water-drive energy and to hold as much of the original gas in solution as possible in the oil until the oil reaches the vicinities of well bores.

Both gas-cap drive and gravity drainage may become important factors in moving oil to well bores.

In solution-gas, water-drive, or combination-drive reservoirs, the production of oil is within reasonable limits independent of well density.

Assuming the same efficiency of operation, the greater the well density the shorter may be the time in years required to produce the recoverable oil from a reservoir. This should be qualified on two counts.

1. The total oil required from a field to fill market demand might be produced as efficiently from fewer widely spaced as from many closely spaced wells.

2. The total oil that could be produced from a reservoir without physical waste might be as efficiently produced from fewer widely spaced as from many closely spaced wells.

Efficient reservoir control to secure maximum benefit of the driving energy is the principal factor in securing maximum oil recovery from a reservoir. Development and operation under unitization is the best way of accomplishing efficient control.

Well spacing should be chosen to fit structural conditions and should consider the characteristics, peculiarities, and irregularities of the reservoir rather than conformation with some regular geometric pattern. In full application, this would necessarily involve unitization.

Economic considerations and expediency necessarily have an important influence in determining well density. Over-all decisions should be made by geologists, engineers, and economists.

Where land-lease controls permit, new oil fields could be first developed on wide spacing patterns. Final well density and other development and production practices could then be determined in the light of geological, engineering, and economic information developed.

Concepts of primary and secondary

Continued on Page 87

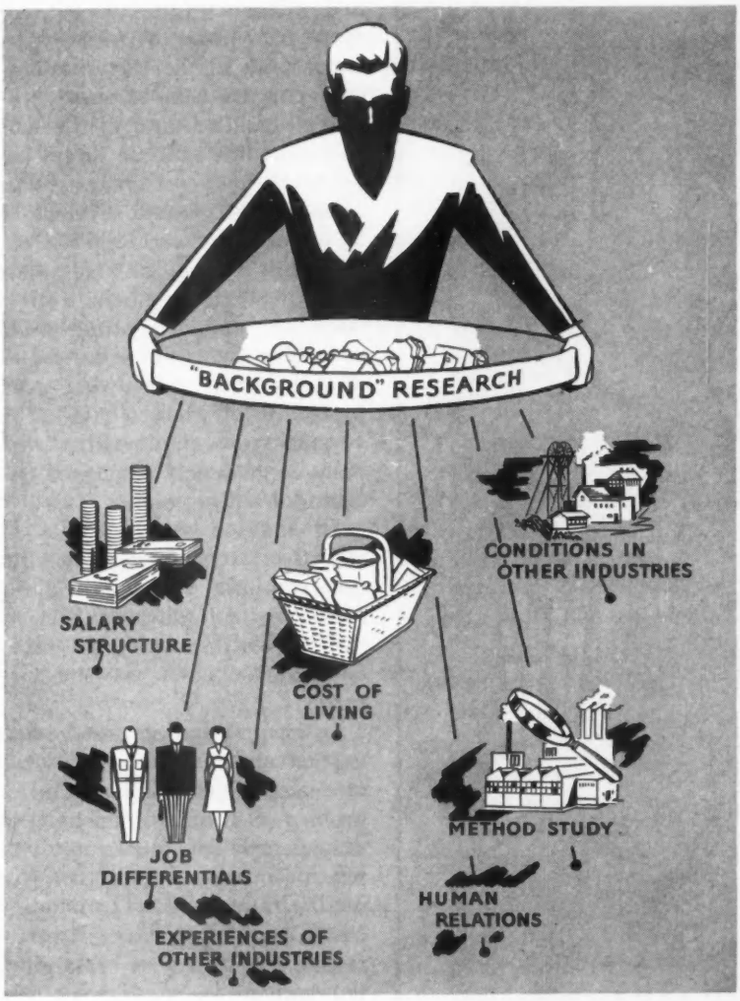
Holman Sees 'Era of Oil Energy'

EUGENE HOLMAN, chairman of the board of Standard Oil Company (New Jersey), has predicted that 1957 will be a better business year than 1956. His company believes, further, he said, that the world stands on the threshold of an "era of oil energy" extending many years into the future.

In spite of the current uncertainties in the Middle East, Jersey Standard plans to spend a record $1¼ billion in 1957 for capital investment and other expenditures in the search for oil and gas. That will be 20 percent more than was spent in 1956.

Holman forecasts a 4 percent rise in domestic oil consumption in 1957, after a gain of about 5½ percent in 1956. Other Free World consumption in 1957 depends on Middle East developments, he said. But in 1956 oil consumption in the other Free countries was up 11 percent over 1955.

Commenting on the price outlook in the U. S., Holman said that while oil prices generally were fairly stable in 1956, the steel strike and subsequent rising costs of steel and other materials, together with higher wage and salary costs, have placed a good deal of upward pressure on prices. Now, with the Middle East supplies sharply reduced and European countries bidding for oil in Western Hemisphere markets, there may be even more pressure exerted toward higher prices for both crude and refined products. Holman cited the example of heavy industrial fuel oil, which is already in short supply and has risen in price under the impact of the Middle East situation.



Background research supplies the facts on which important decisions on employ relations subjects are taken.

Human Relations:

A New Use for Research

Two well known research methods are helping the oil industry improve employe efficiency—obtain more harmonious employe relations.

By E. L. K. FROST
Esso Petroleum Company, Ltd.
London, England

THREE FACTORS are having dynamic influence on the oil industry's attitude toward human relations research work:

- It is a progressive industry and keenly interested in research.
- It believes in the great significance of human factors within the industry.
- The industry is constantly changing and expanding. It recognizes that changes in methods, policies and organization inevitably lead to changes in its human relations.

Result: The oil industry is taking positive action in the field of human relations and its research is paying off in greater employe efficiency and more harmonious employe relations.

In short, the expanding oil industry recognizes the need to place more emphasis on training, communication, recruitment and management development. All these factors are profoundly affected by research in human relations.

What modern human relations research is attempting to provide is a systematic and objective approach to what has often tended, in the past, to be intuitive or even hit-or-miss.

We are, of course, only on the fringe of understanding the problems of man at work in a complex industrial society. Although interesting work has been done in this field, we must be patient and not rush to secure so-called results.

How can the oil industry make use of human relations research in a practical manner? There appear to be two main ways:

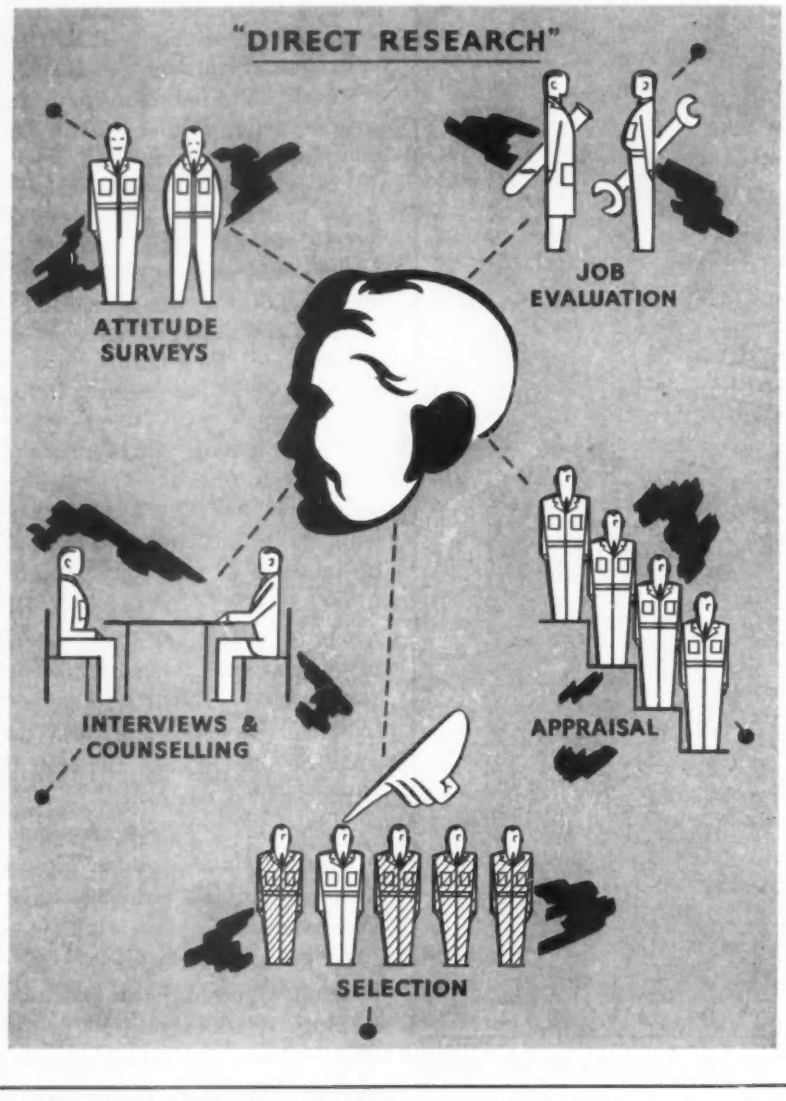
1. "Background" research into the facts on which important decisions on employe relations subjects are taken. This includes wages and salaries, cost of living, job differentials, prevailing conditions in other industries, experiences of other companies and institutions, developments in fields such as method study, and so on. "Background research" also includes keeping in touch with major developments in the industrial relations field.

2. "Direct" research into human relations problems. This includes attitude surveys, research into job evaluation, selection and appraisal, interviewing and counselling.

In other words, the first type of research provides the facts. The second attempts to find a common factor in comparable situations.

The second type of research is, of course, in its infancy; the number of people who appreciate its value to industry are infinitesimal in comparison to those who are aware of the value of physical or sales research.

Background Research. Far-reach-



DIRECT RESEARCH INTO HUMAN RELATIONS: This includes attitude surveys, research into job evaluation, selection and appraisal, interviewing, counselling and so on.

ing employe relations decisions must be based on accurate and objective background research. Any employe relations department in a large industry should have someone whose job it is to provide the basic facts and data on which these decisions can be based.

For example, it is most important that a company should have a just, realistic, flexible and properly understood salary structure. This may not be easy to achieve in—let us say—an expanding and inflationary society. A salary committee must have facts on which to make its decisions. Those facts can only be provided by research into the cost of living, wage rates in other industries, community rates, differentials and labour supply and demand.

Although a company will naturally make its own individual decisions, it is important for it to keep up-to-date with developments in the human relations field in other industries. No company would dream of going over the same ground with regard to research in the physical sciences—it makes use of and profits by the experience of others. Although the human situation is different in every company, there is often relevant data to be obtained —and it is uneconomic not to do so.

Direct Research. Despite the rather tart comment by one writer that every time a manager looks around these days he's sure to find a social scientist studying people at work, there is still too little objective on the problem of human relations in industry.

Undoubtedly the famous Hawthorne experiments carried out in the U. S. by Elton Mayo gave great impetus to the realization that it was possible to locate human factors which had a definite effect on production and efficiency. In the oil industry, there have been well-known surveys carried out in the Esso Standard Oil Company by Elmo Roper.

Well-handled, and in the hands of specialists, the attitude survey can undoubtedly prove of great assistance in assessing the general level of morale in an organization, and in revealing problems. It can also stimulate the interest of management and supervisors in human relations problems; as well as giving employes the chance to voice their views and get their problems "off their chests." The survey also shows employes that the company is genuinely interested in their attitudes and opinions.

In addition to keeping its surveys objective, a company must remember that employes expect to be informed of the broad findings—otherwise they will be less disposed to be frank and co-operative when the next survey is made.

In the oil industry, some interesting research is being conducted by one large American company on the problem of trying to find potential for management jobs. In an industry calling for management of the highest quality, any valid information which could help a company to recognize factors common to successful—and non-successful—management will be of inestimable value in assessing potential executives early in their careers.

Merit-rating is another subject that has been undergoing research in our industry; Jersey's study, "Made to Measure," is a fascinating account of an experiment in a new method of indicating job performance.

Communication Research. A valuable field for research is that of a company's communication methods. Oil companies spend a tremendous amount of money in communicating to their employes—and in getting their employes to communicate to them. Some attempt must be made to assess the effectiveness of a company's communication methods. For example, it is obviously wasteful to produce an employe newspaper regularly without carrying out some objective research to determine whether it is proving effective.

Among many questions in this field which merit investigation are:

Are there blocks in the communica-

tion channels, upwards or downwards?

Are executives burdened with paper work?

How over-worked is the grapevine?

How does the speed and quality of a company's communications compare with that of the trade union?

Organization and Group Research. Two subjects that have provided an incentive for research in recent years are those of organization, and of working groups.

Sometimes a company's organization is considered to be sacrosanct, and pre-ordained. In fact, an organization structure comes into being in response to the work and function of the company, and too often it is kept in being when the work and functions have changed. In this type of situation, the organization may carry on for a while under its own impetus, but sooner or later it will begin to breakdown under stress and strain.

Certainly in the U. S. in recent years there has been a tendency to get away from regarding an organization structure as sacred—and some interesting experiments with rather unorthodox organization structures have led to reducing the numbers of levels of management and supervision.

Recent research in group psychology provides some interesting evidence of the effect of the attitude of the group or team on morale, efficiency, employe turnover, and absenteeism. When one recognizes that the group's attitude in turn very often stems from the influence of one "unofficial leader," then the need for teaching management to recognize and make use of the influence of the unofficial leader is a very practical one.

Finally, training is a major subject that offers tremendous scope for research. In recent years, heretical voices have been raised suggesting that training is largely a waste of time, and that it has little or no impact on those submitted to it. Of course any company who spends, say, $5 million on a new plant, knows only too well that in order to manufacture and market a new product, men must be trained to manage and man the new equipment, and to sell its products.

However, training in an established operation that has been going on for a few years is not always received with such enthusiasm. Here the trained research man has an important job to do in evaluating the impact of such training on those who undergo it. Research can also help to demonstrate—by such means as retention tests—which type of training is most suited to the particular subject in question.

Industry—and the Psychologist. The psychologist has not always been hailed with enthusiasm in the oil industry, but undoubtedly he can help us in dealing with our problems. One of his most important contributions has probably been in that of selection. Research into methods of selecting new employes is definitely time well spent—especially in a vital and expanding industry such as ours that places great emphasis on the quality of the men and women employed. If research can provide any improvement in selection techniques, then it will be helping management to undertake one of its most important functions—choosing the right man for the right job. —**The End**

About the Author

E. L. K. FROST is Employe Relations Manager of Esso Petroleum Company Limited (Great Britain). He was educated at Exeter School, and on leaving the Staff College, Quetta, in 1918, received a regular commission in the Indian Army—serving on the North West Frontier. He joined the Esso Petroleum Company in 1925, and after a career with the sales organization, was appointed industrial relations manager in 1937. During the war, when British oil companies pooled their resources, he was staff manager of the Petroleum Board. After the war he took up his present post.

Lawyer and Engineers . . .

Continued from Page 84

recovery should be merged to consider the two stages of production as one, the continuing primary state.

The trend is toward wider spacing but there is still much work to be done in the way of providing proper legislation.

OIL AND GAS APPRAISALS. The petroleum engineer is closely associated with the lawyer in the appraisal of oil and gas properties. This involves the determination of the value and the reserves of producing oil and gas properties. It is required in many instances for the purchase or the sale of a property, as a basis for inheritance tax, for litigation between interested parties and by the Securities and Exchange Commission in conjunction with public offering of securities.

The petroleum engineer through his studies of the reservoirs from which the oil is being taken can prepare an engineering evaluation. The procedure is to estimate all future income and deduct future operating expense, and other expenditures and taxes. The future income and future expenses may be discounted by compound interest tables to determine present worth. The net result is the actual intrinsic value of a property. Reports which set out the engineering appraisal are supplemented with maps and basic data to substantiate the conclusions.

MISCELLANEOUS FIELDS OF COMMON INTEREST. In addition there are many additional problems where the engineer and lawyer must work together. These include work on basic legislation and all oil and gas problems.

Another very important field for cooperation is the drafting of proper oil and gas codes for foreign governments. Americans have pushed the search for oil to all parts of the world. Many of the areas where exploration for oil is now being carried on have been dormant because these countries did not have provision for granting concessions to American oil companies or the terms of concessions were confusing. The lawyers and engineers have to prepare proper oil laws and proper conservation measures before oil exploration can start. At this time much of this work is being done and it will continue to be an important field for the next few years.

If you get a good idea, "trap it." Keep an "Idea Trap" handy. Jot down your ideas and bring them up at the next meeting. This is an important part of "Creative Thinking."

Creative Thinking Can Pay

There are four steps to dollar profits from creative thinking:

- **Use every idea source at your disposal.**
- **Sift out the good ideas.**
- **If necessary, redefine the problem.**
- **"Sell" your ideas.**

By CHARLES H. CLARK
Ethyl Corporation
New York City

CREATIVE THINKING for everyone, might well be the latest slogan in business. And contrary to general opinion, you don't have to be an Einstein to think creatively. You only have to apply a few simple psychological laws. True, you may not come up with a new way of looking at the universe, but the chances are very good that you'll produce some new ideas that will help your company, and enhance your own value as an employe.

The fact is that few of us ever reach our full potential. Human beings have a tendency to reach a certain point of attainment in their work, and then settle back rather comfortably into what is frequently described as a rut. When a great many individuals in an organization do this, the result can spell disaster for the company.

Many companies have recognized the importance of this problem. Ethyl Corporation for one, has sponsored a course in creative thinking and has obtained excellent results. Basically, the task of thinking creatively can be broken down into four general categories, which can be learned and understood by anyone with normal intelligence.

1. Use Idea Sources. The first thing to do is to use the many sources of ideas available to all of us. New ideas can come from consciously thinking or searching for a better way of doing something or improving an old process. New ideas can also come from the "subconscious mind." That is, after consciously thinking about a subject, just as consciously forget about it, and let the subsoil of the mind work on it.

Many is the discovery or new development that has occurred to man while he was doing something in no way related to the subject. A common example of the subconscious at work is the case of a forgotten name. Many of us have tried to recall a name and been unable to, only to have it pop up into the mind long after we have given up consciously searching for it. This is the "subconscious" mind at work. It never sleeps and it never forgets, psychologists tell us, but it works best when left alone.

Other sources of ideas are conversation with others, or reading, movies, television. Keep an idea bank, creative thinkers say. You may not need the idea immediately, but it will be nice to have some ideas in your account when you want to draw on it. An idea bank can be as simple as a little black notebook and the jotting down of a few key words that will stimulate your thinking. More elaborate idea banks can be a compilation of clippings from newspapers or references to books and articles.

2. Separate "Wheat from Chaff." After you have an idea, or a great many ideas, what should you do with them? Suppose your problem is a lack of money to accomplish what you have set out to do. After you have thought about it consciously and unconsciously, tapped your idea bank, and have made a list of the possible solutions, the next step is to sift and evaluate your ideas. Here is where your critical judgment plays its part. Each idea should be carefully examined, the benefits weighed against the disadvantages, until from the entire list you have decided upon the best possible way.

3. Redefine the Problems. Sometimes however, after you have completed step two, you still have no adequate solution to your problem. In this case, the next thing to do is to redefine your problem. Perhaps you have expressed it in such a manner that a practical solution is impossible and formed a mental block. The great American philosopher John Dewey said: "A problem well stated is half solved."

There are many ways to redefine

a problem. Perhaps you've stated it too loosely. Try tightening it up, keeping it to specifics. Perhaps you don't have the right key word. Try substituting words. This may give you an entirely new slant. It's also a good time to go over your idea bank. There might be something in it that will give your thinking a new slant or direction.

"Sell" the Idea. Let's suppose you have come up with a new idea, or a solution to a difficult problem. Where do you go from there? This is the last and toughest step. Unless you act on your ideas, nothing's going to happen.

If you're not the boss already, the chances are you're going to have to put your idea across to the man above you. This may also be a time to reverse your creative thinking, and do a little destructive thinking on your brain child. At this point, actually try to find as many weak spots in it as you possibly can. Look at it as an idea you didn't have anything to do with, and start tearing it apart. You can be certain your boss is going to do just this, and you'll be that much further ahead if you can anticipate him.

Douse your idea with these three negative cold-water attitudes:

- It looks good on paper, but in actual practice it's not true.
- It probably is true, but it's still of no practical value.
- It's a good idea, but somebody else thought of it first, and it didn't work.

If you can get over these three hurdles you're on the home stretch way in front of the pack. Present your idea imaginatively, figure out the benefits, not only for yourself, but for others, and make it easy for the head man to say yes. Remember, he's busy, but he's always looking for a way to improve on things—if it's presented to him in the proper manner.

To be successful at thinking up new ideas by yourself you have to have one other quality—confidence. Don't sell yourself short, and when the ideas start to come, keep them flowing. Don't block your mental processes by not believing in yourself. Always remember, anyone can come up with good, workable ideas, and the man who does is the man who gets ahead.

How to "Brainstorm." Creative thinkers have also spent a good deal of time working out a method for several people to think at the same time. The name for this group thinking is "brainstorming," and it's a formula that has already produced a legion of labor and money saving ideas.

This teamwork creative thinking is very simple, requires practically no equipment, and there are only a few rules to follow. The first thing needed is a problem, and everyone has plenty of these. Next get a group together with a sufficient understanding of the problem to be able to suggest ideas intelligently. A secretary or a tape recorder to take down ideas is the only other needed equipment.

The chief ingredient of a successful brainstorming session is an unfettered atmosphere, a climate of thinking where anything goes. There should be no do's, don'ts, or can'ts, or any kind of judicial reasoning.

Here are the four rules to be followed in brainstorming:

- Criticism of ideas must be withheld until later.
- "Free wheeling" is welcome! The wilder the ideas the better. It is easier to tame down than to think up.
- Quantity is wanted. The greater the number of ideas, the more likelihood of good ones.

Combination and improvement are sought. In addition to contributing ideas of their own, panel members should suggest how suggestions by others could be turned into better ideas, or how two or more ideas could be combined into a still better idea.

It's also best if possible, to brief panelists a couple of days ahead of time with a one page memo. That gives the "subconscious" time to work on the problem. Let the man who poses the problem answer questions for the first five minutes of the session as a warm up. After that, anything goes.

As the ideas pour out, the secretary or the tape recorder takes them down. Don't worry about judging them until much later. And don't let anyone use "killer phrases" at these sessions, such as "that won't work," it's been tried," or "too expensive." The atmosphere should be anything goes, and it means just that.

One other thing recommended for a good "brainstorming" session is that all of the group be on approximately the same level. A vice president in charge of sales, and a foreman won't be able to relax quickly enough in each others presence to assure a warm, creative atmosphere. The best results usually come when a group is limited to from eight to twelve people.

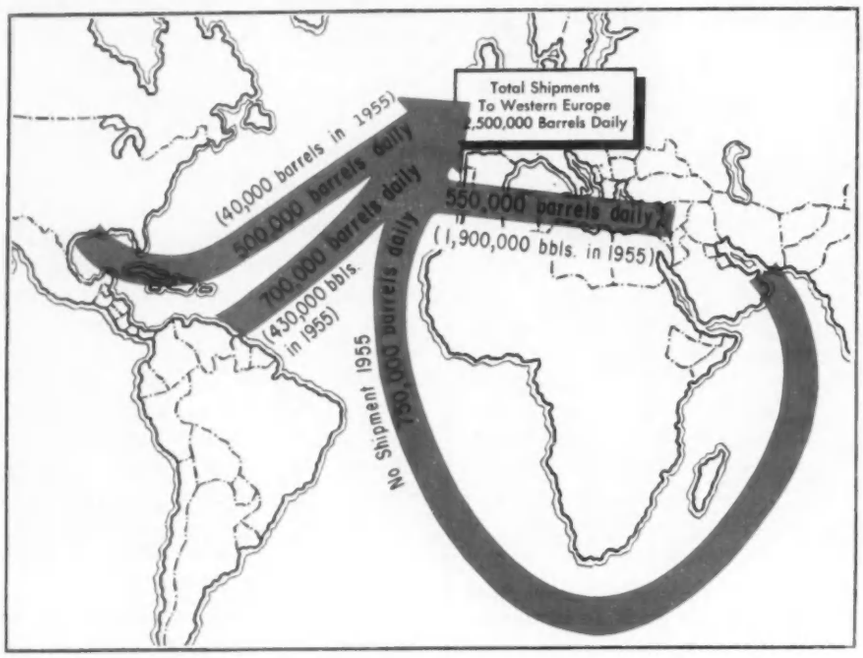
Frequently an off-beat warm up session is used before the real work begins. At one meeting a picture of a mournful dog, was shown and the brainstormers asked for captions for the picture. In four minutes, there were over 90 suggestions. (The winner by applause was "Is *that* the starting salary?"). After that the group went on to turn up 206 ideas in fifteen minutes on a more serious problem.

Brainstorming experts admit that only about six to ten percent of the ideas garnered at a session are workable, but this still adds up to far more than they can count on getting through usual channels. That brainstorming can pay off handsomely was demonstrated last year by the Chicago division of a large corporation. There the plant superintendent and two foremen brainstormed a plan to install a conveyor system, for which $200,000 had been appropriated. They worked out a different system which was installed at a cost of about $4000.

Any way you look at it, individually or in groups, creative thinking can pay. **—The End**

About the Author

CHARLES H. CLARK graduated from Harvard University with an A.G. degree in 1943, and from the University of Pennsylvania with an M.S. degree in education, in 1952. Prior to joining Ethyl Corporation's Public Relations department, he was associated with the Philadelphia Electric Company as an office methods analyst. He has spent several years in research on his specialty, a course on "Creative Thinking." He collaborated on the first college textbook and teachers manual on "Applied Imagination."



Probable oil shipping pattern to Western Europe during first half 1957.

Suez Crisis Puts Pressure On Pipe Lines in U. S.

The U. S. oil industry has been producing—and shipping—more crude oil week by week, but how much more remains a big question.

THE OIL LIFT to Western Europe is moving into high gear this month, with U. S. oil companies straining to meet the paper goals and plans outlined by the Middle East Emergency Committee (MEEC).

Although the plans have turned to action at a phenomenal rate, certain shortcomings have become apparent, thus marring the smooth flow of oil to meet Europe's needs. One glaring example is the apparent inability of U. S. pipe lines to move substantially enlarged quantities of crude from interior producing areas to seaport terminals. It is now obvious that pipe line capacities are inadequate in case of a national emergency.

Between November 1 and December 8, a total of 14 million barrels (528,000 barrels per day) of crude was shipped to Western Europe from Gulf Coast U. S. ports. Of this amount 9 million barrels came from storage, mostly from the Gulf Coast. With higher shipments to Europe due in January, much revamping of pipe lines has been made necessary.

A complete report on oil industry actions to date, including the problems involved in the movement of crude to the Gulf Coast and on to Europe, is presented in detail in the following exclusive WORLD OIL report:

Tankers Turned Away From Gulf Ports. Even though pipe line companies are taking every action possible to move additional crude to the Gulf, tankers are being turned away because of lack of oil.

The British Petroleum Company advised the Texas Railroad Commission it wanted to purchase 3 million barrels of crude at Gulf Coast ports in January, and had the tankers available, but was being forced to re-route the tankers to the Middle East around the Cape of Good Hope because the company was unable to buy enough crude at Gulf ports.

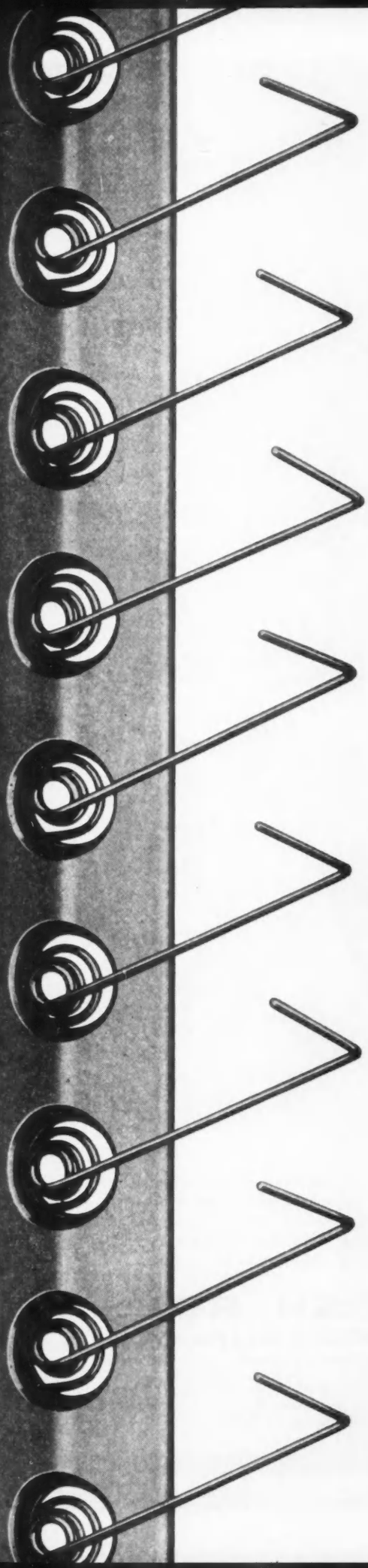
Progress to Date. Despite the current shortage of crude at port terminals, the oil industry has accomplished much in a remarkably short period of time. During July, before the Middle East crisis, tankers lifted 425,000 barrels of crude daily from the Gulf Coast, only 2000 barrels of this amount going to Western Europe. In late November and early December the rate was 1 million barrels daily—the increase going both to the East Coast and to Europe. Product liftings, too, were on the rise.

In short, the U. S. oil industry has been coming up with more crude week by week (see Table) since Operation "Oil Lift" began, but how much more remains a big question.

Basis for Planning. How much "extra" crude the U. S. can provide Western Europe is based on a figure being used extensively within industry and government circles, and by the MEEC, but withheld officially. That figure—the starting point for all emergency planning—is the total average of crude delivered to the Gulf Coast by oil pipe lines during July, 1956—2,635,000 barrels daily.

To show how this figure is being used—indications were that during December 2,910,000 barrels of crude daily were shipped to the Gulf Coast—a gain of 275,000 barrels per day over July.

Potential Pipe Line Capacity. The total potential capacity of pipe lines to the Gulf Coast has increased 62,000 barrels per day in the past six months. The Department of the Interior has estimated that pipe line capacity might be increased to 3,295,000 barrels per day—385,000 barrels per day more than was shipped to the Gulf



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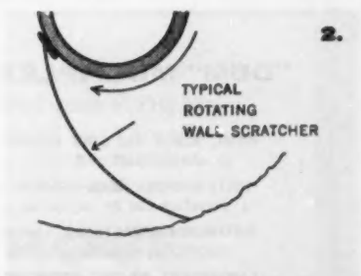

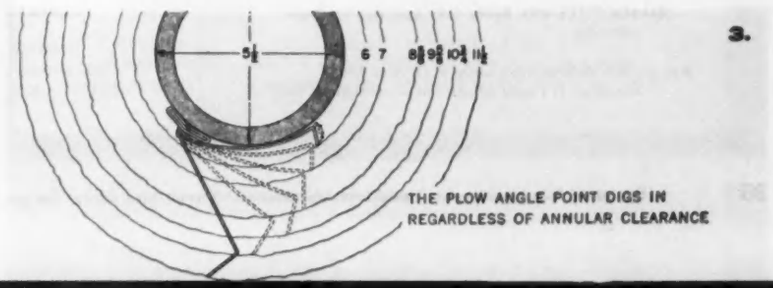

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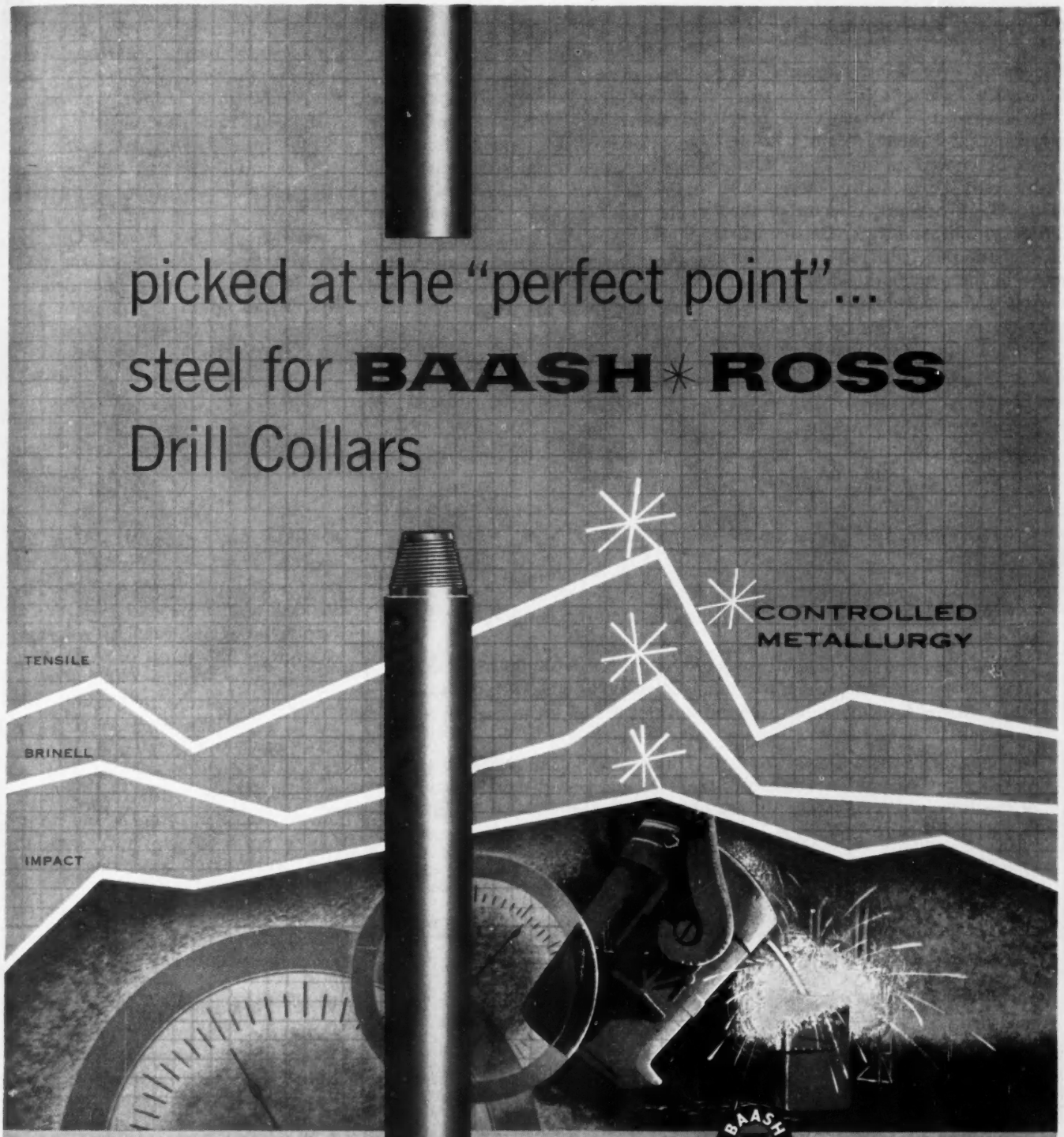

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last month—if all-out measures are taken.

In answer to a WORLD OIL query regarding how much "extra" crude could be moved to the U. S. Gulf Coast from Texas and Louisiana oil fields, Hugh Stewart, director of the Office of Oil and Gas, Department of the Interior, replied: "We can move in the neighborhood of 600,000 barrels a day (over July shipments) through existing pipe line facilities. That might be upped another 50,000 barrels daily, but to go above the 600,000 barrels we would undoubtedly have transportation problems."

Even so, the big boost in pipe line movement will still be a far cry from the 850,000 bpd goal (350,000 barrels to meet East Coast needs—500,000 bpd for Western Europe) that was widely publicized early in December. However, a top official of the Interior Department has spelled out where the rest of the extra crude could possibly come from (on paper at least):

- Pipe lines to increase crude movements to the Gulf 600,000 barrels per day over July totals.
- 150,000 barrels per day could be handled by tank cars.
- 240,000 barrels per day could be shipped by pipe line to Wood River, Chicago, Lima, Ohio, then by tank car to the East Coast.
- 110,000 barrels per day could be moved by barges, railroads and trucks to the Gulf Coast.
- 100,000 barrels per day to be shipped from Venezuela.

The Interior Department emphasized that only the first and last shipping methods are feasible at the present time.

Stewart also told WORLD OIL that the success—or failure—of the 600,000 bpd goal for pipe lines depends entirely on special actions by pipe line companies to divert streams, and to make exchanges and reverse the flow of some lines. Top industry spokesmen say that shipments to inland states may be cut down at any time, at reasonable cost, by reversing or diverting the flow on various lines now in service.

Movements of Crude and Products from U. S. Gulf Coast

Tanker liftings of crude oil from the U. S. Gulf Coast were about 425,000 barrels daily during July of this year. Nearly six months later, in the first week in December, they made a fantastic climb to 1,002,000 barrels daily.

The larger share of the increase is accounted for by shipments of crude oil to Western Europe, which was taking as much as 609,000 barrels daily at the start of December. And the full force of the oil lift to Europe is yet to be felt.

The story of extra liftings from the Gulf is told in the following table prepared for WORLD OIL by the Office of Oil and Gas of the Department of the Interior, in cooperation with officials of oil-producing states and the U. S. Bureau of Mines.

(Thousands of Barrels Daily)

Period and Destination	Crude	Gasoline	Kerosine	Distillate	Residual	Other	Total
July:							
W. Europe	2	20	...	8	...	6	36
August:							
W. Eurpoe	7	32	...	20	5	4	68
September:							
W. Europe	2	17	...	32	1	8	60
October:							
W. Europe	12	14	...	22	...	1	49
November 1-7:							
East Coast	311	564	70	392	147	53	1,537
W. Europe	...	25	...	...	...	16	41
	311	589	70	392	147	69	1,578
November 8-14:							
East Coast	642	704	153	550	115	65	2,229
W. Europe	81	32	...	65	25	9	212
	723	736	153	615	140	...	2,441
November 15-21:							
East Coast	584	514	104	534	185	91	2,012
W. Europe	233	15	2	68	...	3	321
	817	529	106	602	185	94	2,333
November 22-28:							
East Coast	473	639	141	487	134	76	1,950
W. Europe	609	59	14	208	53	1	944
	1,082	698	155	695	187	77	2,894
November 29-December 5:							
East Coast	647	590	130	496	138	84	2,085
W. Europe	355	40	22	212	5	2	636
	1,002	630	152	708	143	86	2,721

Humble Appraises Pipe Line Situation. The most critical area in the supply situation is West Texas-New Mexico where the major portion of surplus producing capacity is located. A study of the status of West Texas pipe lines by Humble Oil & Refining Company indicates that as of January 1, pipe lines from West Texas-New Mexico will be able to move about 1,064,000 barrels daily to the Gulf Coast. In addition, approximately 483,000 barrels are being moved north out of West Texas, and local refineries are using 160,000 barrels.

In October, approximately 850,000 barrels of West Texas-New Mexico crude were moved to the Gulf Coast.

What Pipe Line Companies Have Done. Reports from a number of reliable industry and government sources reveal that the following emergency actions have been taken by various pipe line companies:

- **Humble Pipe Line Company** has increased crude movements to the Gulf Coast 100,000 barrels a day since mid-November.
- **Rancho Pipe Line** to the Gulf Coast is filled to capacity (230,000 bpd). However, a new station is being added at Katy, Texas, which will boost capacity another 25,000 bpd in January.
- **Gulf Oil Company** increased crude movements to the Gulf 30,000 bpd by reversing its 10-inch line from Oklahoma to Lufkin, Texas. Gulf expects to have another 59,000 bpd increase when the West Texas Gulf

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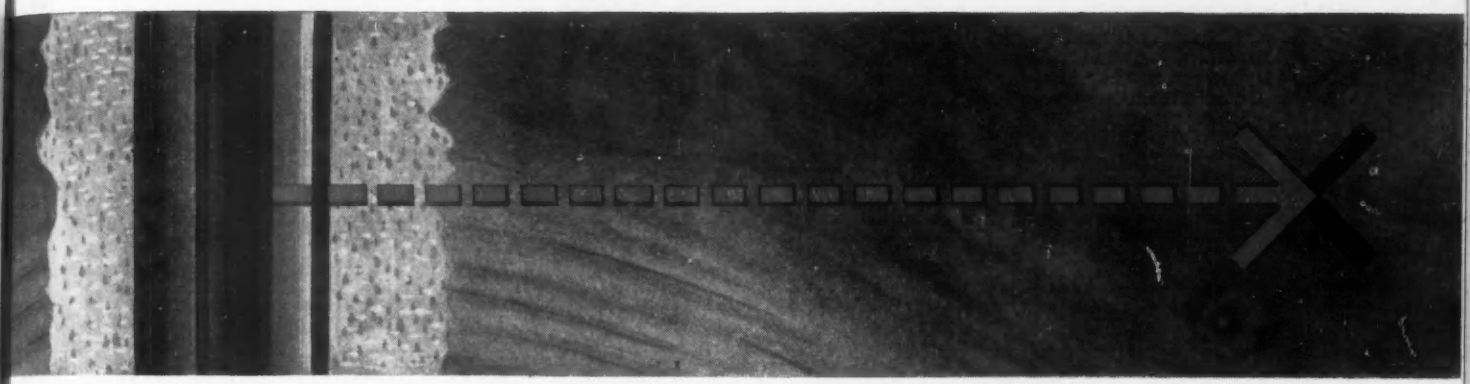

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Pipe Line Company completes its expansion program early in January.

- **Service Pipe Line Company** has boosted pipe line deliveries to the Gulf 17,000 bpd, by adding two booster stations.
- **Standard Oil Company of California** is rushing its studies of a new 600-mile crude line from the Four Corners area to Los Angeles. Other companies would join in if the line is built. However, with present steel shortages the line probably wouldn't be completed before 1958.
- **Carter Oil Company** and others are sending Wyoming's Elk Basin crude on a long voyage via pipe line and barge to the Gulf Coast, then by tanker to Europe.
- **Texas Eastern Transmission Company** is hurrying its action before the FPC for permission to convert parts of its Little Inch to oil products.
- **Underground Exploration Company,** Upper Darby, Pennsylvania, has proposed a tie-in at the Pittsburgh end of the converted Texas Eastern line on to Newark, N. J.
- **Texas Railroad Commission** reports deliveries of crude to the Texas Gulf Coast could be increased 100,000 barrels daily over the October level by reversing some products lines now delivering from coastal refineries to inland cities. However, the Commission says the federal government should initiate any studies along these lines.
- **Texas-New Mexico Pipe Line Company** officials have approved project to construct a 16-inch line from company's Jal, N. M., station to the Four Corners area where Utah, Arizona, New Mexico and Colorado meet. Length: 515 miles. Capacity: 50,000 bpd.
- **Sun Pipe Line Company** is diverting a portion of its deliveries to East Texas, in the amount of 30,000 bpd, to the Gulf Coast.
- **Between 20,000 and 25,000 barrels of oil** are being shipped northeast from West Texas to St. Louis, then taken by barge down the Mississippi River to the Gulf Coast. Much additional oil could be shipped by this expensive routing if enough barges were available.

—The End

If Oil Could Speak

If oil could speak it would have many fascinating truths to tell the non-oil public—truths that would win thousands of new friends for the oil industry.

But, oil can't speak—you can. You, as an individual, can win many new friends for the oil industry if you will pass the true facts on to your non-oil industry friends.

Here are some of those true facts. They are being presented for one purpose: To keep you posted on your industry, so you can tell the story oil is unable to relate.

Read these facts. You will find them informative—and interesting.

"If Oil Could Speak" it would tell the American public:

•

• Last year, the oil industry paid more local, state and federal taxes than any other industry—nearly $5.5 billion, excluding employe income taxes. The oil and gas industry paid Texas $191 million in taxes last year—about one-third of all tax and license revenues paid by industry and business in the state.

•

• In a recent survey, three out of four people thought most of the oil refining done in this country was by three or four large companies. The truth is, the four largest companies do only 37.3 percent of the oil refining, and this ratio is smaller than it was in 1930.

•

• One-fifth of the world's 57 million square miles of land area has oil potential. Of that one-fifth, much less than another one-fifth is located in the U. S. Yet the U. S. has produced 60 percent of all the oil produced to date. Last year alone, our oil producers achieved an output of more than 7 million barrels a day. Private enterprise did it, competition speeded it up.

•

• We are not running out of oil. During the first ten months of 1956, U. S. oil companies discovered more than 1193 new fields, of which 901 were oil and 292 were gas and distillate.

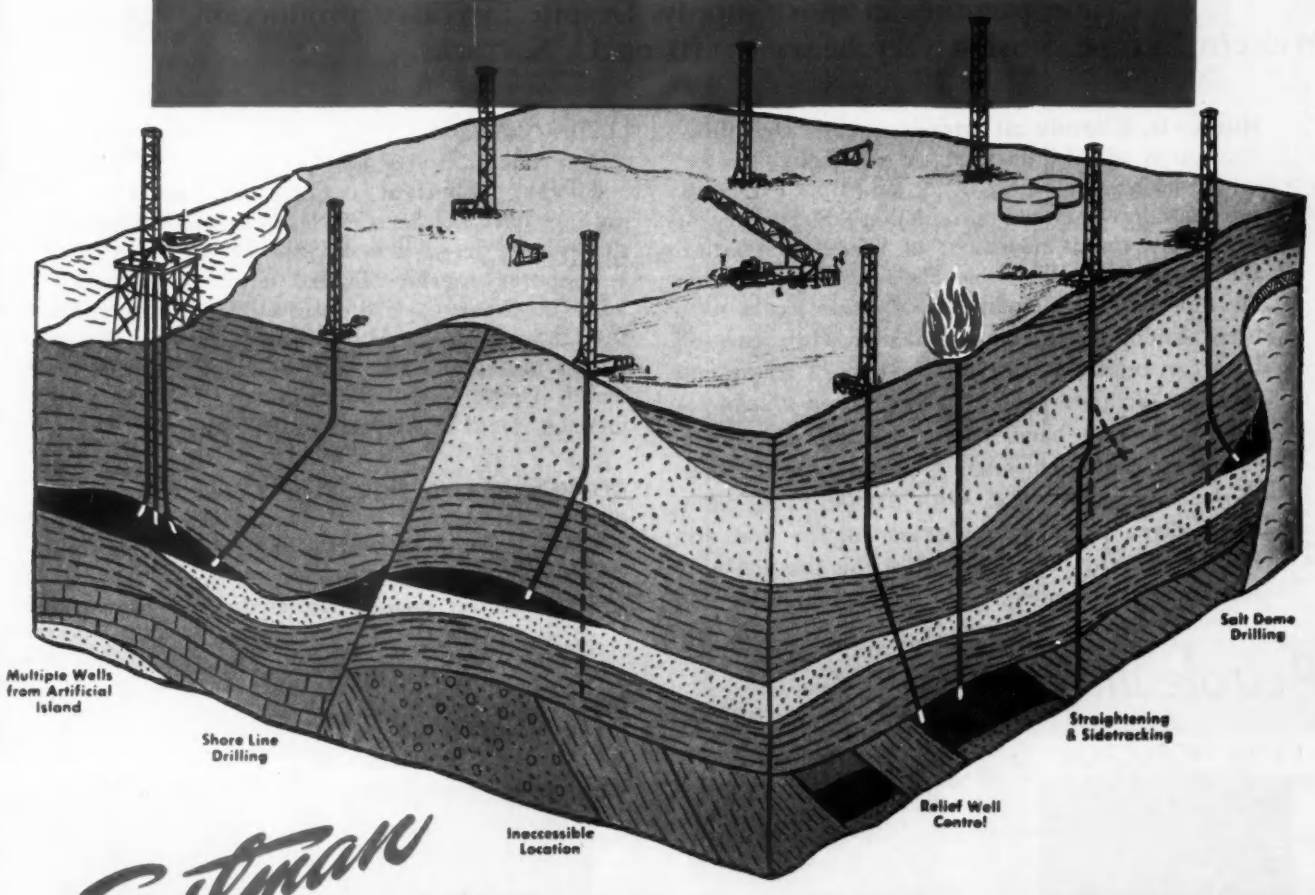
•

• Twenty-five years ago, proved reserves *worldwide* were estimated to be equal to 15 years of production at the 1931 rates. Now the world production rate is four times what it was in 1931, yet exploration has been so successful that present reserves are equal to 33 years at present rates. Again, private enterprise and competition have been responsible for nearly 100 percent of our oil discoveries.

•

Remember: Oil can't speak—you can. Only you can give the non-oil public the true facts about your oil industry.

DIRECTIONAL DRILLING...?
SIDETRACKING...?
OIL WELL SURVEYING...?



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3. We are pioneers of oil well bore hole surveying.

4. First to offer free engineering consultation service, job planning and proposals on directional drilling and sidetracking problems.

5. The only service company manufacturing its own complete line of tools and instruments for directional drilling and sub-surface surveying.

6. Constant supervision of all jobs by area superintendents.

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By **RAY L. DUDLEY,** Publisher, and **WARREN L. BAKER,** Editor

U. S. Crude Prices May Be Advanced

Crude becomes in short supply. Despite increased production, shipments to Western Europe causing very heavy drafts on U. S. stocks.

Higher U. S. crude oil prices may be in the offing. Disruption of Middle East oil shipments has resulted in a very tight U. S. oil supply. Despite substantially enlarged production during recent weeks, increased movement of crude to Western Europe from the U. S. has caused heavy drafts on inventories. Excess quantities of crude stocks have been eliminated. There is a demand for more oil than can be moved to Gulf Coast ports by present pipe line facilities.

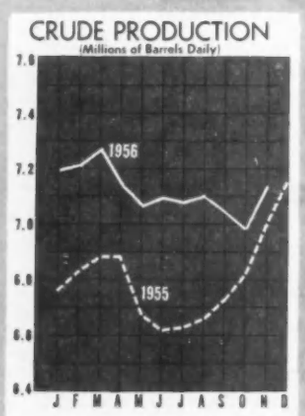
On the other hand, excessive stocks of gasoline still exist, although some improvement has been shown in recent weeks. With distillate fuel oil in heavy demand during this season of the year and Europe wanting large volumes of this product also, some fear has been expressed that refiners may step up their operations. This would result in making of too much gasoline for this time of the year.

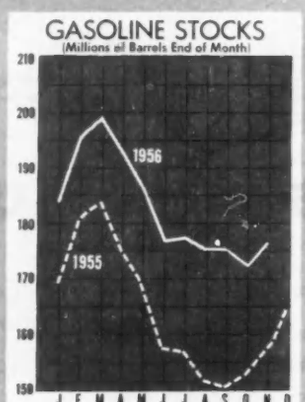
Another important reason why higher crude postings have not been made is the knowledge that the present large demand for U. S. crude is of a temporary nature. It will terminate when the Suez Canal gets back in operation, and at that time the U. S. will be faced with the necessity of reducing its production back to the level of normal demand. Under such circumstances, a crude price increase might not be maintained for long.

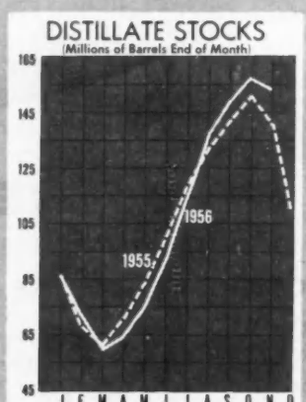
•

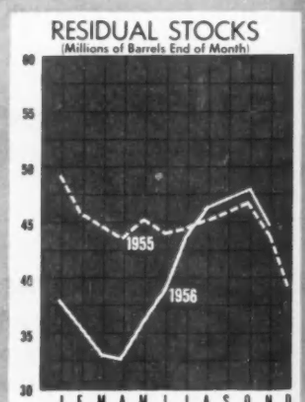
Crude is in very tight supply and is certain to remain this way for some months. At the December Texas proration hearing major crude purchasers requested increased production during January. Five purchasers wanted two additional producing

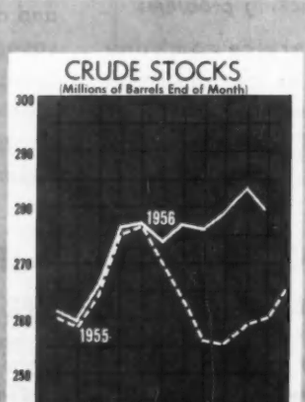
Petroleum Trends . . .

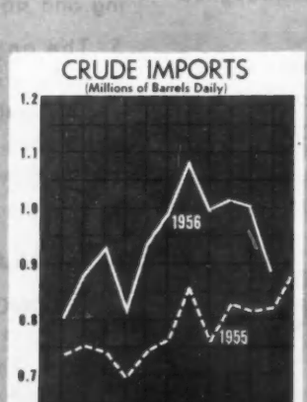


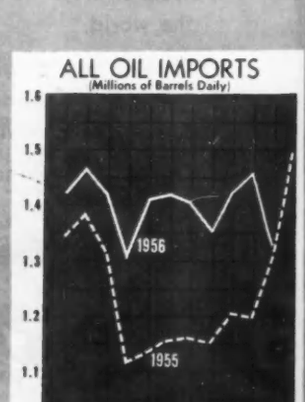












days, or about 300,000 barrels more oil per day. Six recommended one more producing day, or approximately 150,000 barrels more daily. Several purchasers indicated they had a demand for more oil, but that their nominations for increased production were based on ability to move oil to the Gulf for export shipment.

It has been necessary to turn some tankers away from Gulf ports because insufficient crude was available. British Petroleum has been unable to buy 3 million barrels at Gulf Coast ports for January shipment, and is being forced to reroute tankers to the Middle East around the Cape of Good Hope.

Humble Oil & Refining Company has been able to supply only 165,000 barrels per day of a demand from Esso Export Company for 300,000 barrels per day in December, although Humble has bought all the spot oil possible and drawn extensively on storage. Humble would like to buy 170,000 barrels daily, if the oil could be delivered to the Gulf Coast.

The situation is even tight in Oklahoma. Esso Export has been trying to buy 10,000 barrels daily in Oklahoma, but has succeeded in purchasing only 2000 barrels.

•

Talk of increased crude prices is being fanned by several recent developments. The U. S. is being called upon to supply approximately 800,000 barrels of additional crude oil per day as a result of the disruption of Middle East oil shipments. Despite increased production of 140,000 barrels daily in November, stocks of crude oil declined 9 million barrels (528,000 barrels per day) between November 1 and December 8. They now total only 273 million barrels, but slightly over the 265 million barrels generally considered necessary to fill pipe lines and provide adequate working inventories.

Further drafts on stocks are certain although production in December appeared likely to be at an all-time high of 7⅓ million barrels per day, ⅓ million more than in October and ¼ million greater than in November. In January enough oil must be produced to fill needs, including that of Europe, as stocks will not permit continued heavy drafts.

U. S. Crude Production

(THOUSANDS OF BARRELS)

STATE or DISTRICT	DAILY AVERAGE PRODUCTION Nov., 1956	Oct., 1956	Nov., 1955	% Dif. Nov., 1956-1955	TOTAL PRODUCTION FIRST ELEVEN MONTHS 1956	1955	% Dif. 1956-1955
Alabama	11.2	10.2	3.9	+187.2	2,689	1,241	+ 16.7
Arkansas	78.6	77.7	76.7	+ 2.5	26,381	26,121	+ 0.1
California	950.8	955.5	976.0	— 2.6	322,284	324,501	— 0.7
Colorado	155.7	158.6	148.9	+ 4.6	53,686	46,193	+ 16.2
Florida	1.3	1.3	1.4	— 7.2	442	448	— 1.3
Illinois	236.3	235.6	229.3	+ 3.1	75,813	74,533	+ 1.7
Indiana	31.9	31.6	31.7	+ 0.6	10,172	10,109	+ 0.6
Kansas	331.9	335.2	333.1	— 0.4	113,707	111,432	+ 2.0
Kentucky	46.7	47.1	43.1	+ 8.4	15,917	13,872	+ 14.7
Louisiana	843.7	796.0	777.1	+ 8.6	269,220	243,816	+ 10.4
North Louisiana	126.4	120.1	123.5	+ 2.3	42,240	39,971	+ 5.7
South Louisiana	717.3	675.9	653.6	+ 9.7	226,980	203,845	+ 11.3
Michigan	28.6	26.8	29.9	— 4.4	9,889	10,336	— 4.3
Mississippi	114.0	113.6	110.4	+ 3.3	37,250	33,847	+ 10.1
Missouri	0.2	0.2	0.2	.....	55	61	— 9.8
Montana	66.3	65.0	42.0	+ 57.9	19,725	14,121	+ 39.7
Nebraska	38.6	38.5	31.6	+ 22.2	14,165	8,726	+ 62.3
Nevada	0.2	0.2	0.1	+100.0	63	56	+ 12.5
New Mexico	241.9	242.3	235.0	+ 2.9	80,095	74,893	+ 6.9
Southeast New Mexico	240.0	240.5	232.7	+ 3.1	78,959	73,970	+ 6.7
Northwest New Mexico	1.9	1.8	2.3	— 17.4	1,136	923	+ 23.1
New York	7.7	7.8	7.7	.....	2,523	2,675	— 5.7
North Dakota	38.0	26.5	36.3	+ 4.7	11,991	9,938	+ 20.7
Ohio	12.9	13.7	12.2	+ 5.7	4,347	3,927	+ 10.7
Oklahoma	571.6	560.6	583.4	— 2.0	196,264	184,485	+ 6.4
Pennsylvania	22.7	22.8	22.4	+ 1.3	7,529	7,749	— 2.8
South Dakota	0.1	0.1	0.1	.....	31	28	+ 10.7
Tennessee	0.1	0.1	0.1	.....	15	15	.....
Texas	3,005.7	2,932.5	2,996.7	+ 0.3	1,015,601	963,952	+ 5.4
Dist. 1: South Central	57.4	56.6	54.3	+ 5.7	18,407	17,074	+ 7.8
Dist. 2: Middle Gulf	153.2	149.1	159.3	— 3.8	52,137	50,413	+ 3.4
Dist. 3: Upper Gulf	444.7	435.5	433.2	+ 2.7	151,225	150,176	+ 0.7
Dist. 4: Lower Gulf-S.W.	232.0	233.4	244.0	— 4.9	81,218	81,397	— 0.2
Dist. 5: East Central	39.4	41.2	49.0	— 19.6	14,830	16,206	— 8.5
Dist. 6: Northeast	332.6	323.4	349.1	— 4.7	114,218	115,132	— 0.8
Dist. 7-B: North Central	155.2	157.8	149.1	+ 4.1	52,423	47,734	+ 9.8
Dist. 7-C: West Central	175.6	174.4	174.1	+ 0.9	61,533	60,741	+ 1.3
Dist. 8: West	1,100.1	1,047.3	965.7	+ 13.9	352,048	313,012	+ 12.5
Dist. 9: North	210.4	211.5	214.6	— 2.0	70,765	66,887	+ 5.8
Dist. 10: Panhandle	105.1	102.3	90.2	+ 16.5	32,576	29,532	+ 10.3
Utah	8.2	6.8	3.4	+141.2	2,020	1,896	+ 6.5
Virginia	0.1	0.1	0.1	.....	13	11	+ 18.2
West Virginia	5.8	6.1	6.4	— 9.4	2,008	2,136	— 6.0
Wyoming	285.7	283.6	274.5	+ 4.1	95,726	91,599	+ 4.5
TOTAL UNITED STATES	7,136.5	6,996.1	7,013.7	+ 1.8	2,389,621	2,262,717	+ 5.6

U. S. Crude Oil and Refined Product Trends

(THOUSANDS OF BARRELS)

MONTH	CRUDE OIL Production Daily	Runs to Stills Daily	Stocks End of Month	GASOLINE Production Daily	Stocks End of Month	DISTILLATE FUEL Production Daily	Stocks End of Month	RESIDUAL FUEL Production Daily	Stocks End of Month	DAILY IMPORTS Crude Oil	Total Oils
1955:											
March	6,886	7,374	264,430	3,543	183,972	1,703	62,457	1,185	44,970	742	1,319
April	6,887	7,136	275,232	3,502	175,601	1,534	70,139	1,110	43,838	697	1,123
May	6,677	7,281	276,948	3,605	168,751	1,519	83,559	1,111	45,083	742	1,137
June	6,613	7,484	270,850	3,725	157,439	1,628	100,652	1,080	44,398	764	1,159
July	6,632	7,580	264,601	3,824	157,079	1,575	119,169	1,091	44,894	860	1,161
August	6,665	7,580	256,427	3,858	151,912	1,621	133,675	1,090	45,480	756	1,155
September	6,731	7,483	256,269	3,784	150,194	1,621	143,248	1,061	46,267	829	1,218
October	6,831	7,465	267,346	3,827	153,103	1,612	152,288	1,123	47,040	821	1,206
November	7,014	7,692	260,707	3,867	157,871	1,680	141,808	1,214	44,071	823	1,322
December	7,155	7,762	265,610	3,916	165,433	1,765	111,333	1,286	39,174	884	1,502
1956:											
January	7,199	8,023	261,592	3,927	183,905	1,923	86,141	1,344	38,247	805	1,422
February	7,208	8,047	259,504	3,854	196,092	1,918	71,335	1,286	35,673	878	1,472
March	7,278	7,914	265,683	3,829	199,698	1,808	60,846	1,213	32,984	934	1,425
April	7,146	7,487	277,121	3,646	193,299	1,713	63,571	1,130	32,740	815	1,305
May	7,064	7,896	277,497	3,859	186,673	1,667	75,928	1,149	36,607	938	1,416
June	7,100	8,071	274,491	3,976	177,076	1,755	93,758	1,098	39,073	987	1,426
July	7,090	8,014	277,008	3,975	176,536	1,767	115,787	1,066	43,958	1,084	1,463
August	7,195	7,995	279,944	4,037	172,939	1,839	137,905	1,091	46,617	1,001	1,399
September	7,054	8,024	278,791	3,991	177,974	1,845	150,411	1,062	47,342	1,043	1,452
October	6,996	7,638	283,164	3,744	172,534	1,776	158,483	1,107	47,988	1,005	1,461
November	7,137	8,027	275,910	3,825	175,405	1,822	153,384	1,183	44,376	881	1,323
Week Ended:											
12-14-56	7,355	8,000	273,617*	3,867	177,037	1,943	139,610	1,194	43,145	692	1,227
12-16-55	6,946	7,684	258,059	3,867	160,406	1,725	126,040	1,232	40,935	847	1,348

Source: Data for last two months from API; prior monthly data from Bureau of Mines.
* Crude Stocks on 12-7-56.

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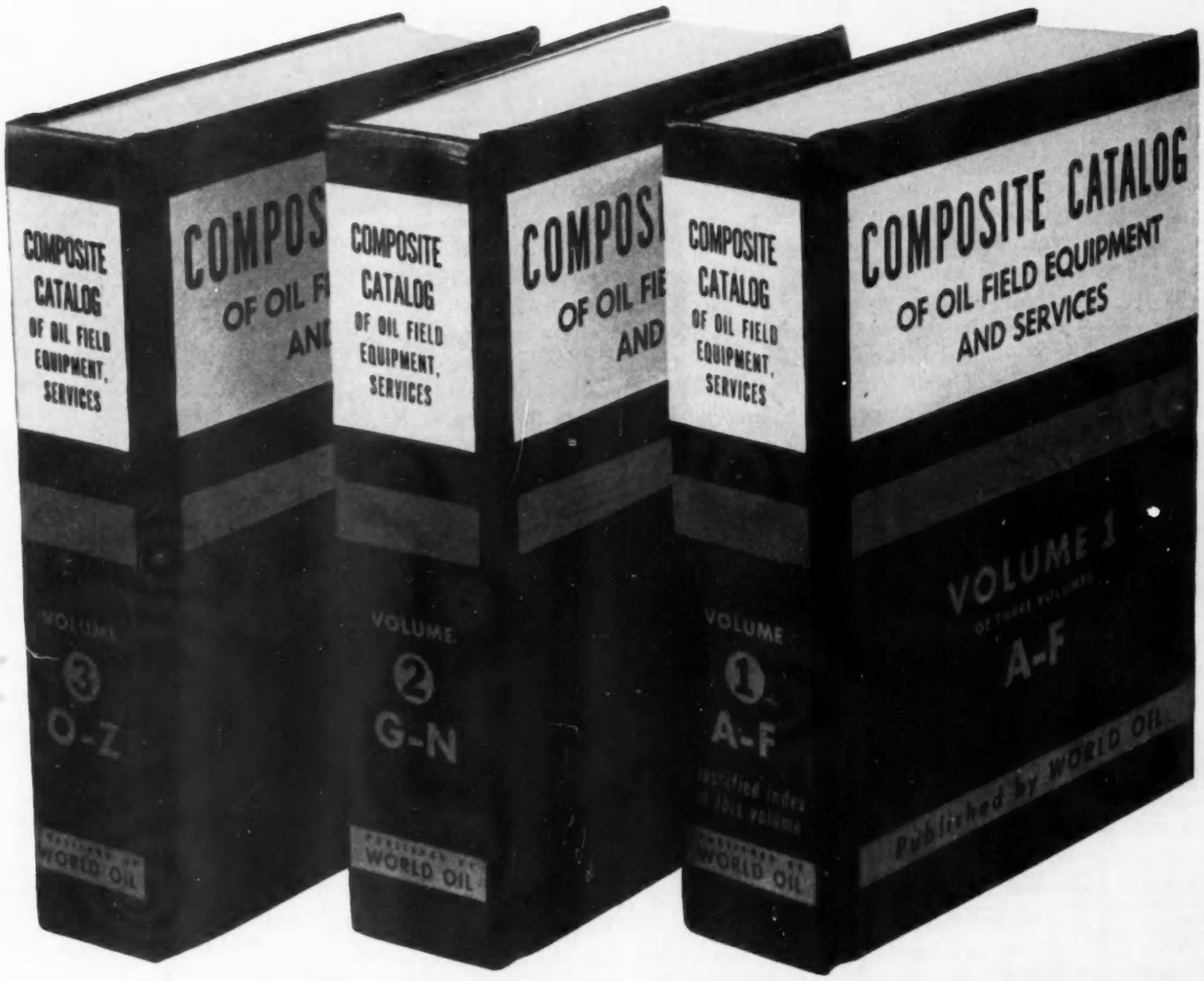

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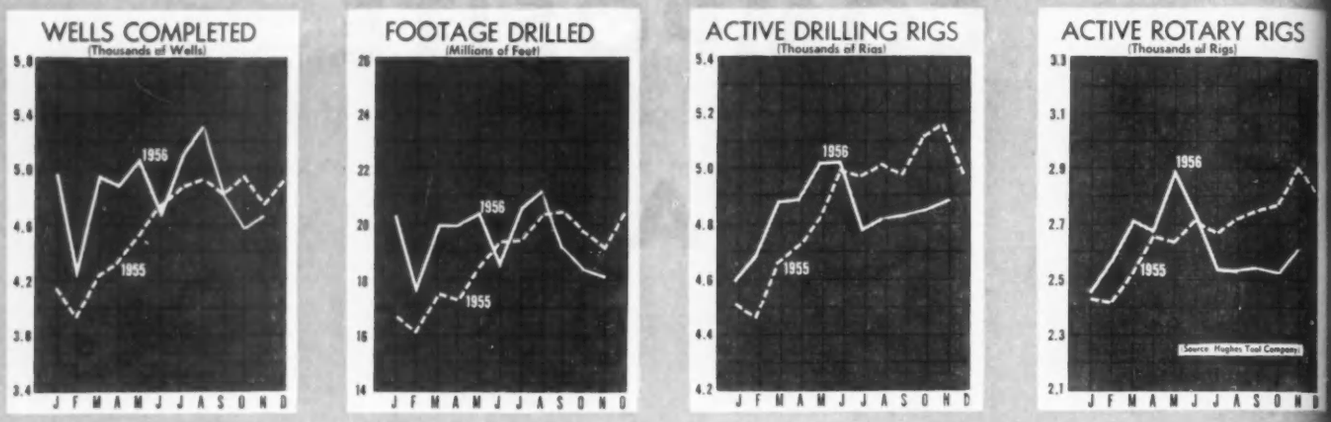
Drilling Activities . . .



Drilling Begins to Recover

By **CECIL W. SMITH,** WORLD OIL Staff

SEVERAL MONTHS ago the nation's drilling program ran headlong into pipe shortage conditions brought on by the recent steel industry strike. High drilling rates that had characterized the first half of last year's schedule were suddenly depressed. The low-point was reached in October when the number of wells completed was down almost 15 percent from August's peak.

But the climb back has begun. Recovery will be slow, but some improvement was evident in November. The number of active drilling rigs has slowly increased, and the resulting well completions have moved upward. November's new wells were only 22 more than the 4594 recorded in October, but a fairer comparison shows that 154 wells were completed daily in November, while the average was only 148 a month earlier.

Despite the serious setback, last year's drilling held a 5.5 percent edge over the previous all-time high set in 1955. However, this lead has been whittled sharply the past several months, but with a month to go in 1956, there was no doubt that a new drilling peak would be reached.

At the end of eleven months, a total of 53,430 new wells had been completed in the U. S. That represented a gain of 5.5 percent over the 50,648 recorded in the same period of 1955, but it was nearly 1000 wells short of earlier expectations. The year's total should be slightly more than 58,000 new wells, which will be a new high for the industry.

Shortages of tubular goods were reflected in lessening of average depths to which wells were being drilled, as well as cutting down the numbers. Footage statistics show that operators are favoring the shallower locations in this period of tight pipe supply. Well depths in 1956 did not keep pace with 1955, but the past several months saw this average lowered considerably.

At the end of July the national average well depth was 4066 feet. That was lowered to 4057 by the end of August, and at the end of eleven months, average depth was 4031 feet. That was exactly 50 feet shallower than the average a year earlier.

Of the five leading drilling states, three have been the sites of increased activity in 1956. These top three states, Texas, Oklahoma, and Kansas, accounted for 60 percent of the nation's wells, and in both Texas and Kansas the average well depth was shallower than it had been a year earlier. This fact strongly affected the national average.

The leading state was, of course, Texas, where a total of 20,544 new wells was completed against 1955's 18,031 for a gain of 12.3 percent. That state's average well was drilled to 4239 feet, while a year earlier the average had been 4378 feet. This drop was principally due to increased number of wells in the north and west parts of the state. In those sectors, 42 percent of the state's wells were drilled and in each district the average depth was less than it had been.

Oklahoma, the number two drilling area, saw a small 1.7 percent hike in activity with 7139 wells. This was one of the few major states where average depths increased.

Summary of U. S. Wildcat Drilling

ITEM	Nov., 1956	Oct., 1956	ELEVEN MONTHS January-November 1956	1955	Percent Dif.
New Field Discoveries:					
Oil	70	86	974	1,001	— 2.7
Distillate	10	5	101	116	—12.9
Gas	18	25	219	212	+ 3.3
Total Discoveries	98	116	1,294	1,329	— 2.6
Dry Wildcats	919	862	10,120	9,104	+11.2
Total Wildcats	1,017	978	11,414	10,433	+ 9.4
Percent Productive	9.6	11.9	11.3	12.7	.....
Percent Dry	90.4	88.1	88.7	87.3	.....

(See Page 108 for details)

Summary of U. S. Drilling Activities

ITEM	Nov., 1956	Oct., 1956	ELEVEN MONTHS January-November 1956	1955	Percent Dif.
New Wells Completed:					
Oil	2,319	2,401	28,167	27,857	+ 1.1
Distillate	45	32	514	670	—23.3
Gas	329	358	3,645	3,111	+17.2
Service	127	99	942	607	+55.2
Dry	1,796	1,712	20,162	18,403	+ 9.6
Total Wells	4,616	4,594	53,430	50,648	+ 5.5
Footage Drilled (Mln. of Feet)	18.1	18.4	215.4	206.7	+ 4.2

(See Page 108 for details)

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U. S. Drilling Activity in November and First Eleven Months, 1956-1955

STATE or DISTRICT	TOTAL NEW WELLS COMPLETED AND FOOTAGE DRILLED: DETAILS FOR NOVEMBER, 1956 — Oil	Dist.	Gas	Dry	Service Wells	TOTAL NEW WELLS — Nov., 1956	Oct., 1956	Nov., 1955	Total Footage November, 1956	DETAILS FOR JANUARY-NOVEMBER — NEW WELLS — 1956	1955	Percent Diff.	FOOTAGE — 1956	1955
Alabama	6			5		11	8	3	100,660	87	39	+123.1	740,062	174,445
Arizona								1		7	5	+ 40.0	22,048	22,518
Arkansas	71		1	31		103	107	86	276,394	918	736	+ 24.7	2,745,692	2,381,272
California	149		3	46	3	201	170	204	870,536	1,994	2,198	— 9.3	9,200,769	10,817,836
Colorado	18		10	72		100	109	118	523,017	1,164	1,400	— 16.9	5,983,774	7,490,226
Florida				1		1	3	1	11,600	13	25	— 48.0	82,307	175,167
Georgia							2	1		7	2	+250.0	30,149	9,305
Idaho										1	3	— 66.8	4,528	11,337
Illinois	103		5	149		257	294	318	558,453	3,415	3,504	— 2.6	7,868,285	8,423,080
Indiana	20			35	3	58	61	67	107,616	623	582	+ 7.0	1,091,104	913,835
Kansas	183		30	179	10	402	388	400	1,435,496	4,288	4,255	+ 0.8	15,170,722	16,092,542
Kentucky	52		16	69		137	166	176	206,347	1,717	1,552	+ 10.6	2,552,649	2,303,581
Louisiana	157	3	40	109		309	321	378	2,096,783	3,410	3,881	— 12.1	24,862,014	25,761,372
North Louisiana	90		17	47		154	151	164	544,723	1,507	1,945	— 22.5	5,434,933	6,151,426
South Louisiana	67	3	23	62		155	170	214	1,552,060	1,903	1,936	— 1.7	19,427,081	19,609,946
* Gulf of Mexico	14	1	6	11		32	42	40	320,909	392	317	+ 23.7	3,724,436	3,175,372
Maryland										4			30,716	
Michigan	16		1	14		31	31	34	93,225	398	477	— 16.6	1,137,021	1,418,459
Mississippi	10		1	22		33	34	45	226,540	395	424	— 6.8	2,850,466	3,089,643
Missouri							4			25	24	+ 4.2	27,153	13,095
Montana	24			25		49	40	47	231,766	463	339	+ 36.6	2,292,846	1,642,812
Nebraska	12			38		50	60	70	299,734	841	779	+ 8.0	4,868,657	4,468,843
Nevada				1		1			8,042	6	6		36,613	44,828
New Mexico	76		60	35		171	160	155	681,672	1,817	1,588	+ 14.4	8,086,308	6,807,664
New York	43		3	3	27	76	50	34	117,600	472	337	+ 40.1	684,200	466,936
North Dakota	10			6		16	31	20	140,158	256	237	+ 8.0	1,898,293	1,673,527
Ohio	39		21	19		79	89	105	194,412	940	1,097	— 14.3	2,264,082	2,283,798
Oklahoma	316	6	27	182	24	555	559	622	1,907,453	7,139	7,022	+ 1.7	25,405,337	24,325,941
Oregon										1	1		12,880	7,101
Pennsylvania	41		21	7	43	112	93	58	266,565	863	672	+ 28.4	2,302,750	1,273,598
South Dakota				3		3	1		6,749	20	12	+ 66.7	67,714	52,476
Texas	930	36	47	697	17	1,727	1,665	1,764	7,219,375	20,544	18,031	+ 12.3	87,076,731	78,941,652
Dist. 1: South Central	73		6	63		142	156	162	326,290	1,863	1,646	+ 13.2	4,783,577	4,378,265
Dist. 2: Middle Gulf	22	10	8	14		54	65	84	294,432	760	760		4,603,125	4,592,512
Dist. 3: Upper Gulf	71	10	4	78		163	146	131	1,166,768	1,671	1,625	+ 2.8	11,408,688	10,436,763
* Gulf of Mexico				3		3	4	1	23,592	16	14	+ 14.3	162,082	137,881
Dist. 4: Lower Gulf-S.W.	44	13	2	63		122	105	98	631,576	1,333	1,222	+ 9.1	6,954,493	6,474,190
* Gulf of Mexico		1				1	1		8,085	12	12		105,183	115,549
Dist. 5: East Central	3		1	16		20	16	22	73,915	225	239	— 5.9	794,765	927,346
Dist. 6: Northeast	34	3	6	53		96	91	84	508,222	876	683	+ 28.3	4,688,757	3,638,139
Dist. 7-B: North Central	93		3	109		205	190	288	737,554	2,763	2,861	— 3.4	9,856,328	9,292,416
Dist. 7-C: West Central	37		1	29		67	74	97	295,284	1,144	1,075	+ 6.4	5,228,504	5,749,247
Dist. 8: West	295		2	65	3	365	339	362	1,830,554	3,934	3,568	+ 10.3	20,195,740	19,211,073
Dist. 9: North	180		2	195	14	391	372	363	967,601	4,692	3,464	+ 35.5	13,448,616	11,106,956
Dist. 10: Panhandle	78		12	12		102	111	73	387,179	1,293	888	+ 45.6	5,114,138	3,134,745
Utah	7			12		19	10	6	86,261	134	93	+ 44.1	627,333	400,485
Washington		..								1			7,493	
West Virginia	6	..	34	8		48	57	52	143,333	635	590	+ 7.6	1,720,910	1,561,146
Wyoming	30		9	28		67	81	65	241,897	832	737	+ 12.9	3,647,677	3,645,374
Total United States	2,319	45	329	1,796	127	4,616	4,594	4,830	18,051,684	53,430	50,648	+ 5.5	215,399,283	206,693,894
Total Western Canada	316		5	157	2	480	161	279	2,179,216	2,813	2,412	+ 16.6	13,116,683	10,423,735

WILDCAT DRILLING IN NOVEMBER AND FIRST ELEVEN MONTHS, 1956-1955: DETAILS FOR NOV., 1956 — Oil	Dist.	Gas	Dry	Total Wildcats	DETAILS FOR JANUARY-NOVEMBER — Oil	Dist.	Gas	Dry	TOTAL WILDCATS — 1956	1955	DRILLING RIGS IN OPERATION — Nov. 30, 1956	Oct. 31, 1956	Nov. 30, 1955
			4	4			2	24	26	37	16	13	8
							2	5	7	5	1		
			11	11	11		4	120	135	140	77	75	52
2			27	29	12		7	245	264	335	190	197	225
2		4	54	60	25	1	14	584	624	739	69	78	96
			1	1				13	13	24	2	2	1
								7	7	2	1	1	2
								1	1	3			
1			73	74	17		1	879	897	675	266	277	311
			16	16	5			160	165	176	109	107	101
9		5	83	97	144		40	950	1,134	1,064	548	534	490
			7	7	6			128	134	103	120	120	138
6	1	1	52	60	44	28	17	518	607	521	421	411	398
3			18	21	13	2	2	199	216	196	72	79	78
3	1	1	34	39	31	26	15	319	391	325	349	332	320
1	1		5	7	6	6	5	46	63	23	74	56	52
											1	1	2
			7	7	4		2	135	141	181	73	72	87
2			15	17	11	2		170	183	175	41	35	35
								16	16	17	1	1	3
			21	22	8		2	177	187	142	59	60	55
2			23	25	39		1	367	407	353	28	24	42
			1	1				4	4	4	4	5	3
8			16	24	42	1	1	215	259	195	162	175	168
										1	78	68	53
			4	4	9			69	78	64	31	26	27
								3	3	16	228	225	215
10	2	3	48	63	93	15	32	613	753	712	572	572	685
								1	1	1			
										3	198	178	122
			3	3				19	19	12	7	3	2
27	7	5	422	461	489	52	87	4,399	5,027	4,431	1,261	1,284	1,510
			47	47	21	1	5	487	514	404	34	41	50
2	1		10	13	14	8	7	220	249	291	40	32	41
	3	1	45	49	19	11	5	410	445	423	156	155	141
			3	3				12	12	5	4	6	3
	3		43	46	21	20	19	401	461	421	83	87	83
								1	1	3	2	3	3
			14	14				131	131	129	11	7	11
2		2	18	22	13	1	4	203	221	180	77	67	71
3			77	80	148		15	882	1,045	1,017	104	115	168
		1	21	22	42		3	259	304	303	94	110	135
8			39	47	94	3	2	383	482	473	343	339	455
11			102	113	97	2	8	937	1,044	738	212	235	255
1		1	6	8	20	6	19	86	131	52	107	96	100
			11	11	6		3	76	85	78	31	35	33
								1	1				
										21	195	196	181
			20	20	9	2	4	221	236	203	92	90	115
70	10	18	919	1,017	974	101	219	10,120	11,414	10,433	4,882	4,865	5,160
											222	218	228

* Gulf of Mexico wells are included in their respective district totals.

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Uranium Exploration Methods Offer Advantages in Petroleum Finding

Sedimentary terranes include favorable host rocks for uranium deposition. Deposition requires a transmissive host rock and a suitable depositional trap. These conditions are also present in petroleum accumulations and exploration methods and knowledge employed in the search for oil may be applied to uranium reconnaissance.

By **JACK KRATCHMAN**
U. S. Atomic Energy Commission
Washington, D. C.

IN RECENT YEARS the tempo of participation by the petroleum industry in the search for uranium has increased steadily. Interest in many cases is prompted by a desire to share in the growth or investigate the future of uranium as a nuclear fuel.

At the beginning of the government exploration program in 1947, uranium was considered a rare metal and the few mines which produced it were thought to be anomalous. Subsequent discoveries have proven that uranium is present in the earth's crust in greater amounts than originally believed and exploitable ore bodies are numerous.

Because its solubility and polyvalence allows combination with many elements, uranium is readily removed from concentrations where it is in a low valence form and dispersed in many depositional environments. Fortunately, this dissipation is selective in the sense that mineable concentrations of uranium ore are found more frequently in certain types of environments than in others.

In the past, vein deposits in metamorphic and igneous rocks provided the major portion of our production and were believed to represent the most important potential source rocks for uranium. Recent discoveries of major deposits in the Blind river area, Canada; the Witwatersrand, South Africa; and the Colorado plateau of the U. S. have emphasized the favorability of sedimentary host rocks.

In sedimentary terranes, the problem of locating uranium is somewhat similar to that of finding petroleum because both substances require the presence of favorable sedimentary beds to provide a transmissive host rock and a suitable depositional trap.

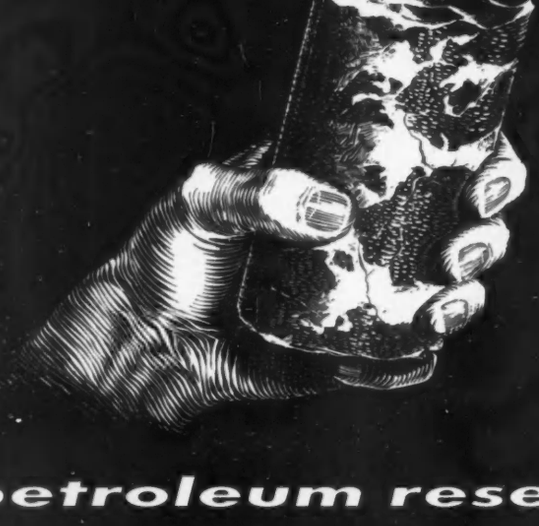
A favorable transmissive host rock for uranium is frequently characterized by sharp lateral variations in the lithology. These same features are also present in numerous reservoir sands containing important oil accumulations. The host rocks of the oil fields of Rumania and the Caucasus Apsheron province of Russia, for example, have rapid facies changes distinguished by scouring and channeling, cross-bedding, textural and mineralogic differences, and irregular areal patterns. Many of the Pennsylvanian sands of the Appalachian, Illinois and Mid-Continent regions exhibit similar forms (Levorsen, 1954).

In contrast to these similarities, important differences also exist. The preferred host rocks for petroleum accumulations are marine sediments, whereas sandstone and conglomeratic strata of fluvial origin form the hosts for the uranium deposits of the western U. S. In addition, petroleum accumulates in virtually the same state in which it migrates while deposits of uranium represent a precipitate, at the ore site, from a complex solvent.

If precipitation of the uranium-bearing solute takes place in a reducing environment the uranium ion is in a tetravalent state which may or may not be stable under oxidizing conditions, depending on the mineral form in which uranium occurs. Under oxidizing conditions there is an increase in the valence state to hexavalent and complex uranyl compounds may form. This propensity for ionic changes affects the form in which accumulation takes place and introduces additional exploration problems. For this reason it becomes desirable for the petroleum industry to become familiar with the various types of features by which potentially favorable sedimentary terranes for uranium may be defined, and the application of appropriate exploration techniques.

Among the sedimentary rocks in which uranium has been found are continental sandstone and conglomerate, tuffaceous sediments, coal and carbonaceous shale, limestone, black shale, and phosphorite. The most important of these are the continental sandstones and conglomerates. The quantity of precipitation of uranium within these hosts is affected by the concentration of uranium in the migratory solution, the velocity of the

AS CLOSE AS YOU CAN GET....



to a petroleum reservoir

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solution, the nature of the aquifer and trap, and chemical conditions.

In the western U. S., ore-bearing strata usually consists of lenticular sandstone, commonly medium to coarse-grained, pale to light brown, cross-bedded, and of fluvial origin and which may be classified as orthoquartzites, arkoses or sedimentary tuffs (Cadigan, 1952). These sandstone bodies are frequently found interbedded or interfingered with red, green, or variegated siltstone and claystone with associated carbonaceous material.

Deposition and the distribution of the uranium values are affected frequently by local sedimentary structures which changed the attitude of the permeable bed carrying the ore solutions and influenced its transmissivity. Other structural features which may serve to concentrate uranium ore are paleostream channels occupied by sandstone, and fracture zones of various types.

It is impossible to list a single mineral assemblage which would characterize all of the uranium ore deposits in the sedimentary formations of the western U. S. However, among uranium ores three mineralogic suites are predominant and are distinguishable on the basis of the relative abundance of vanadium and copper:

- A high vanadium-low copper ore suite characterized by a preponderance of vanadium minerals, and vanadiferous clays together with the uraniferous vanadate, carnotite. Uraninite and coffinite accompany these minerals and are presumably the unoxidized remnants of the original deposit.

- A high copper-low vanadium ore suite consisting of uraninite and copper sulphides. Hydrated sulfates of uranium and secondary copper minerals are common.

- A low vanadium-low copper group in which uraninite together with uranyl carbonates, sulfates, phosphates, arsenates, and silicates is prominent.

The oxidized secondary uranium, vanadium, and copper minerals form characteristically yellow, green, orange, and blue coatings, stains, and efflorescences.

In general terms then, the nature of the object of search as it most frequently occurs in the United States is defined. We must now consider the means by which this search may fit, with minimum expense and maximum effect, into the framework of petroleum exploration operations. Petroleum exploration usually encompasses some or all of the following methods:

A. Geologic Methods
   1. Surface mapping
   2. Subsurface mapping

B. Physical Exploration Methods

C. Geophysical Methods

In the surface mapping of sedimentary rocks the characteristics of favorable host rocks for uranium should be borne in mind continually, and if promising outcroppings are discovered they should be examined with a radiation detection instrument such as a Geiger counter or a scintillation counter. There are many types and models of these instruments, ranging in price from $35 to $375 for Geiger counters and from $300 to $1000 for scintillation counters. Anyone can operate a counter and the ability of the instrument to detect radioactivity enables the prospector to operate effectively. Recordings on a counter do not always accurately reflect the uranium content of a test specimen and must be supplemented by visual observation, sampling, and chemical assaying.

In reconnaissance the prospector walks slowly over a selected area and observes any changes in the amount of radioactivity. If an area of radioactive rock is discovered, it is often helpful to make a systematic grid survey by taking readings and contouring these values plotted on a map. The contours of equal radioactivity will indicate the size, shape and trend of the anomaly and the intensity of the radiation.

The extension of geologic mapping to three dimensions by drilling frequently is accompanied by the preparation of subsurface geologic maps. Structural, isopach, and facies maps are among the types of subsurface geologic maps that are commonly employed in the petroleum industry. If maps of these types are available, they should be examined carefully for information which may be useful in the search for uranium.

In the Edgemont district of South Dakota, most ore deposits are found where there is a change in the attitude of the strata that generally dip less than five degrees. The recognition of terraces, monoclines, and small anticlinal noses becomes an important prospecting objective, and structural contour maps drawn on the top of the host rock serve to focus attention on these potentially favorable structural features.

The Ambrosia Lake district, north of Grants, New Mexico, a new major discovery provides another example of control, by structure, of uranium deposits. Only preliminary drilling results are available but it appears from the structural contour map of the main area that the ore bears a distinct spatial relationship to the flanks of the anticlinal and domal structures which are present in the area.

Structural maps may also reveal other features worthy of attention such as faults, possible spatial relations to major tectonic features, joint patterns and trends of sedimentation as evidenced by ripple marks, crossbedding and various types of lineation features.

Isopachous maps may be used with greatest effect when approximate ore distribution patterns are known or when regional sedimentational criteria have been developed. Craig (1955) has shown that a major source of the uranium-bearing Salt Wash member of the Morrison formation is to the southwest of south central Utah and that most of the ore bodies are found in areas where the Salt Wash member exceeds 240 feet in thickness. Weir (1952) has established, by statistical analysis, that the sandstone beds in which the carnotite deposits are found are between 20 and 80 feet thick with a minimum thickness of 40 feet for large ore deposits.

In the event that a large scale isopachous map is developed, it may be possible to delineate paleostream channels which may be filled with favorable clastics. The sand-filled channels of the Booch sand of the Hawkins field, Hughes County, Oklahoma, are delineated in this way as illustrated by Busch (1950). Favorable zones within these sedimentary structures frequently are found in the lower portion of the channelfill. (Wright, 1955).

Lithologic variations influence ore distribution and concentration. Facies maps illustrating these modifications in rock type have become an import-

ant adjunct to uranium exploration. Those areas in which rapidly changing facies are predominant are the most favorable for deposition, and a sandstone to mudstone ratio of approximately 1:1 is especially favorable (Masters, 1955). The mean intrinsic transmissivity of mudstones of the Morrison formation has been established by Jobin (1955) to be zero while sandstones of the Morrison formation are highly variable with a mean transmissivity of 3.8. The areas of intermediate permeability represented on facies maps by the mudstone-sandstone ratio of 1:1 provide the optimum environment for precipitation of uranium from solution in a favorable physico-chemical system.

Occasionally color variations may be correlative with commercial concentrations of uranium because gray and limonitic brown colors usually are associated with ore-bearing sandstone and red colors with barren rock.

In addition to the preparation of various types of subsurface maps from information derived from widespread drilling, each drill hole or seismic shot hole provides an opportunity to test for possible unusual, subsurface radioactivity. This may be done by scanning the core or cuttings from the drill hole with radiation detection instruments or by gamma ray logging of the holes. The chief advantage of gamma ray logs lies in their ability to locate precisely the depth from which anomalous radioactivity is emanating.

Mining costs rise sharply with increasing depth and there is a variable limit to the depth at which mineralized strata may be mined at a profit. It is desirable, nonetheless, to check deep drill holes to their bottom because the cut-off depth varies and the same formation may be closer to the surface or possibly crop out in adjacent areas.

Application of geophysical techniques to uranium exploration has been limited because of the small size of the uranium ore bodies and associated geologic features, and the insufficient contrast between the physical properties of the uranium and the surrounding rock. It is possible, however, that lithologic and structural irregularities delineated by seismic refraction and electrical resistivity profiling, supplemented with other data may be used to delineate areas for further study.

Although many are concerned with exploration developments in the eastern U. S., those criteria and methods which have been developed in producing areas in the western U. S. have been emphasized because knowledge of the geologic characteristics of the uranium in sedimentary rocks in the eastern U. S. is limited, and none of these occurrences are of commercial importance.

Minor deposits of uranium in sedimentary terranes in the eastern U. S. have been discovered in the Triassic Basins of Connecticut, New Jersey, and Pennsylvania; the Valley and Ridge province of eastern and central Pennsylvania; and the Appalachian plateaus of northern Pennsylvania and southeastern New York. These deposits range in age from Devonian to Middle Triassic; the larger deposits are found in the upper Paleozoic formations.

The Newark Basin in New Jersey and Pennsylvania has been the scene of the greatest number of discoveries in Triassic sediments. Eleven traces of uraniferous argillite in the Lockatong formation and seven traces of uraniferous sandstone in the Stockton formation have been described (McKeown, 1954). The most noteworthy uranium occurrence is in the Stockton formation and consists of a small carbonaceous, bedding plane lens containing uraninite and pyrite. This lens is in a light brown to yellow, medium-grained sandstone occupying the lower portion of a paleostream channel. Argillic and limonitic alteration are present.

The deposits located in the Catskill formation of Devonian age and the Pottsville formation of Pennsylvanian age, in the Valley and Ridge Province and the Appalachian plateaus are the most promising in the eastern U. S. to date, and bear an interesting resemblance to the deposits on the Colorado plateau. Both areas contain uranium mineralization disseminated in sandstone or conglomerate and associated with carbonaceous material; and copper is associated with uranium in some but not all of the deposits. Sedimentary features which have influenced ore distribution, such as ancient stream channels, are common. These associations suggest that the criteria developed in the western U. S. may be applied in comparable places in the eastern U. S. It should be remembered, however, that exploration criteria are not always applicable to new areas and visible traces of mineralization or similar direct evidence are still the best guides.

At present, the uranium potential of the eastern United States is unknown. Exploration has been confined largely to road traverses, examination of mines and dumps, prospect evaluations, and semi-detailed reconnaissance near known uranium occurrences. The eastern U. S. has no specific geologic unit which can be described as a uranium province, as has the Colorado plateau, nor does it contain a producing uranium mine. It does have, however, a number of geologic units comparable to those of uranium producing areas elsewhere in the world, and uranium of good grade and limited quantity has been discovered in rocks which vary widely in age.

Numerous discoveries are made in the fields of metal and fuel exploration without the benefit of formal or scientific application of proven geologic or geophysical methods. However, the ratio of success to failure is demonstrably higher for that exploration which is based on scientifically developed evidence than for random searching. The degree of participation in uranium exploration by any operator is determined by his varying needs or capabilities but, regardless of the extent of his participation, the operator should make use of the expanding geologic literature on uranium exploration to guide his efforts.

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Logs and Cores Indicate Porosity

Sidewall coring, combined with contact logging, is an important addition to exploratory tools used in hard rock country.

By C. R. MILLER, JR., and C. B. EVANS
Schlumberger Well Surveying Corporation
Oklahoma City

AMONG THE DATA necessary for successful exploration and exploitation of oil fields, porosity is of paramount importance. Various processes therefore have been developed toward determination of this factor.

- 1. Laboratory analysis of conventional and side wall cores.
- 2. Computation from resistivity measurements including short normal spacings, Limestone Device, Contact Logs, and Laterologs.

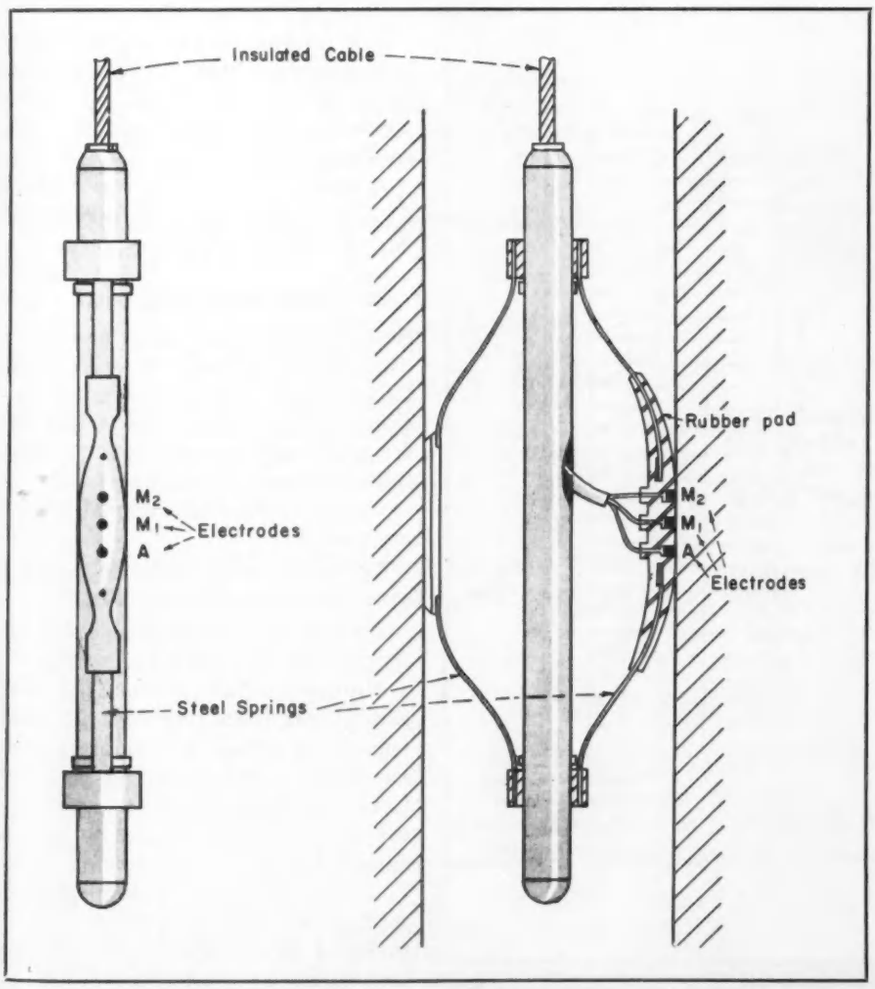

FIGURE 1—Contact logging apparatus showing distribution of electrodes.

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Theory of quantitative determinations of porosity has appeared several

ant adjunct to uranium exploration. Those areas in which rapidly changing facies are predominant are the most favorable for deposition, and a sandstone to mudstone ratio of approximately 1:1 is especially favorable (Masters, 1955). The mean intrinsic transmissivity of mudstones of the Morrison formation has been established by Jobin (1955) to be zero while sandstones of the Morrison formation are highly variable with a mean transmissivity of 3.8. The areas of intermediate permeability represented on facies maps by the mudstone-sandstone ratio of 1:1 provide the optimum environment for precipitation of uranium from solution in a favorable physico-chemical system.

Occasionally color variations may be correlative with commercial concentrations of uranium because gray and limonitic brown colors usually are associated with ore-bearing sandstone and red colors with barren rock.

In addition to the preparation of various types of subsurface maps from information derived from widespread drilling, each drill hole or seismic shot hole provides an opportunity to test for possible unusual, subsurface radioactivity. This may be done by scanning the core or cuttings from the drill hole with radiation detection instruments or by gamma ray logging of the holes. The chief advantage of gamma ray logs lies in their ability to locate precisely the depth from which anomalous radioactivity is emanating.

Mining costs rise sharply with increasing depth and there is a variable limit to the depth at which mineralized strata may be mined at a profit. It is desirable, nonetheless, to check deep drill holes to their bottom because the cut-off depth varies and the same formation may be closer to the surface or possibly crop out in adjacent areas.

Application of geophysical techniques to uranium exploration has been limited because of the small size of the uranium ore bodies and associated geologic features, and the insufficient contrast between the physical properties of the uranium and the surrounding rock. It is possible, however, that lithologic and structural irregularities delineated by seismic refraction and electrical resistivity profiling, supplemented with other data may be used to delineate areas for further study.

Although many are concerned with exploration developments in the eastern U. S., those criteria and methods which have been developed in producing areas in the western U. S. have been emphasized because knowledge of the geologic characteristics of the uranium in sedimentary rocks in the eastern U. S. is limited, and none of these occurrences are of commercial importance.

Minor deposits of uranium in sedimentary terranes in the eastern U. S. have been discovered in the Triassic Basins of Connecticut, New Jersey, and Pennsylvania; the Valley and Ridge province of eastern and central Pennsylvania; and the Appalachian plateaus of northern Pennsylvania and southeastern New York. These deposits range in age from Devonian to Middle Triassic; the larger deposits are found in the upper Paleozoic formations.

The Newark Basin in New Jersey and Pennsylvania has been the scene of the greatest number of discoveries in Triassic sediments. Eleven traces of uraniferous argillite in the Lockatong formation and seven traces of uraniferous sandstone in the Stockton formation have been described (McKeown, 1954). The most noteworthy uranium occurrence is in the Stockton formation and consists of a small carbonaceous, bedding plane lens containing uraninite and pyrite. This lens is in a light brown to yellow, medium-grained sandstone occupying the lower portion of a paleostream channel. Argillic and limonitic alteration are present.

The deposits located in the Catskill formation of Devonian age and the Pottsville formation of Pennsylvanian age, in the Valley and Ridge Province and the Appalachian plateaus are the most promising in the eastern U. S. to date, and bear an interesting resemblance to the deposits on the Colorado plateau. Both areas contain uranium mineralization disseminated in sandstone or conglomerate and associated with carbonaceous material; and copper is associated with uranium in some but not all of the deposits. Sedimentary features which have influenced ore distribution, such as ancient stream channels, are common. These associations suggest that the criteria developed in the western U. S. may be applied in comparable places in the eastern U. S. It should be remembered, however, that exploration criteria are not always applicable to new areas and visible traces of mineralization or similar direct evidence are still the best guides.

At present, the uranium potential of the eastern United States is unknown. Exploration has been confined largely to road traverses, examination of mines and dumps, prospect evaluations, and semi-detailed reconnaissance near known uranium occurrences. The eastern U. S. has no specific geologic unit which can be described as a uranium province, as has the Colorado plateau, nor does it contain a producing uranium mine. It does have, however, a number of geologic units comparable to those of uranium producing areas elsewhere in the world, and uranium of good grade and limited quantity has been discovered in rocks which vary widely in age.

Numerous discoveries are made in the fields of metal and fuel exploration without the benefit of formal or scientific application of proven geologic or geophysical methods. However, the ratio of success to failure is demonstrably higher for that exploration which is based on scientifically developed evidence than for random searching. The degree of participation in uranium exploration by any operator is determined by his varying needs or capabilities but, regardless of the extent of his participation, the operator should make use of the expanding geologic literature on uranium exploration to guide his efforts.

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ACKNOWLEDGMENT

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Logs and Cores Indicate Porosity

Sidewall coring, combined with contact logging, is an important addition to exploratory tools used in hard rock country.

By C. R. MILLER, JR., and C. B. EVANS
Schlumberger Well Surveying Corporation
Oklahoma City

AMONG THE DATA necessary for successful exploration and exploitation of oil fields, porosity is of paramount importance. Various processes therefore have been developed toward determination of this factor.

- 1. Laboratory analysis of conventional and side wall cores.
- 2. Computation from resistivity measurements including short normal spacings, Limestone Device, Contact Logs, and Laterologs.

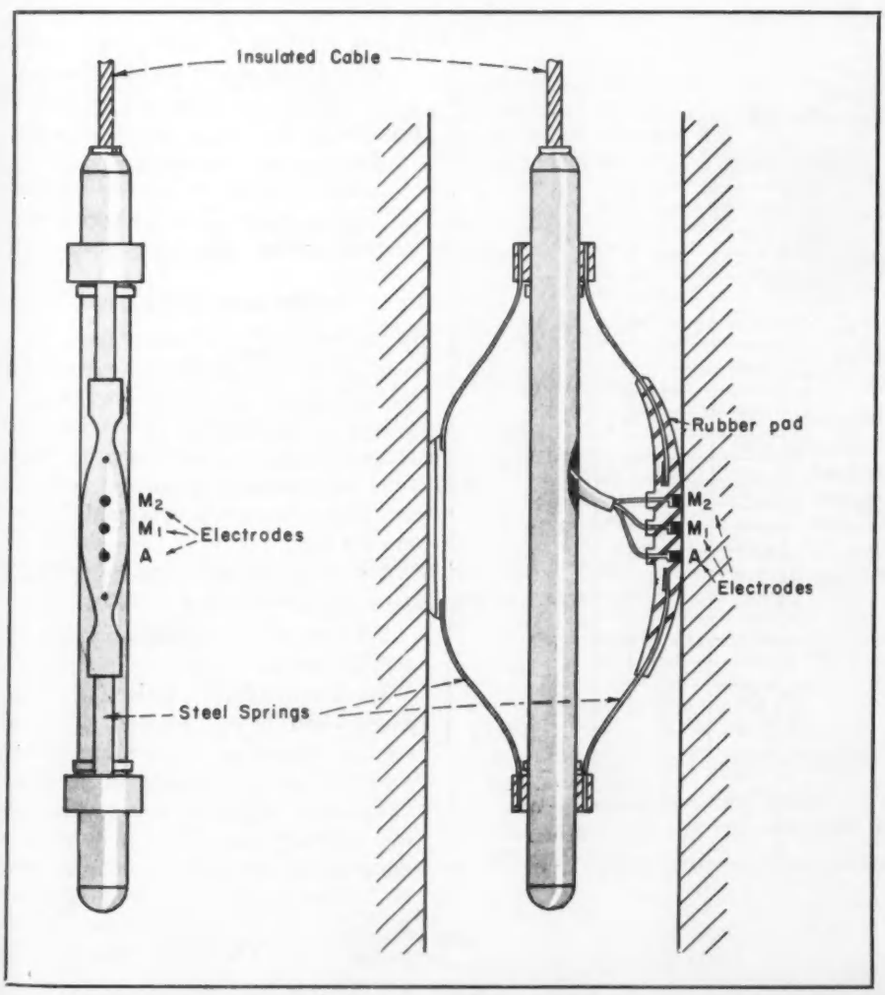

FIGURE 1—Contact logging apparatus showing distribution of electrodes.

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Comparison of the porosities obtained from side wall core analysis with those computed from Contact Log readings shows a close check. This is especially true in the range of porosity most frequently encountered in Oklahoma.

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Contact Logging Technique. Resistivity measurements are made with very small electrode systems. To eliminate influence of the bore hole, the electrodes are mounted on a rubber pad which is pressed against the wall of the hole by a spring arrangement. The present tool will function properly in holes from 6 inches to 14 inches in diameter. Curves give the resistivity of small volumes near the wall of the hole. Figure 1 shows this pad and the spring arrangement.

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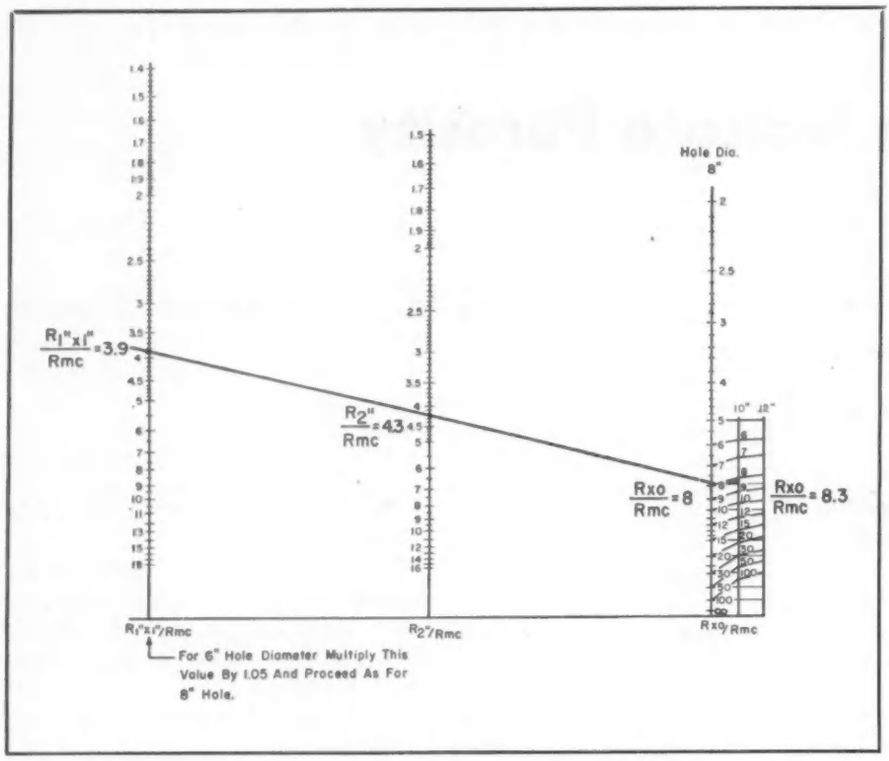

FIGURE 2—Nomographic contact log chart—hydraulic pad.

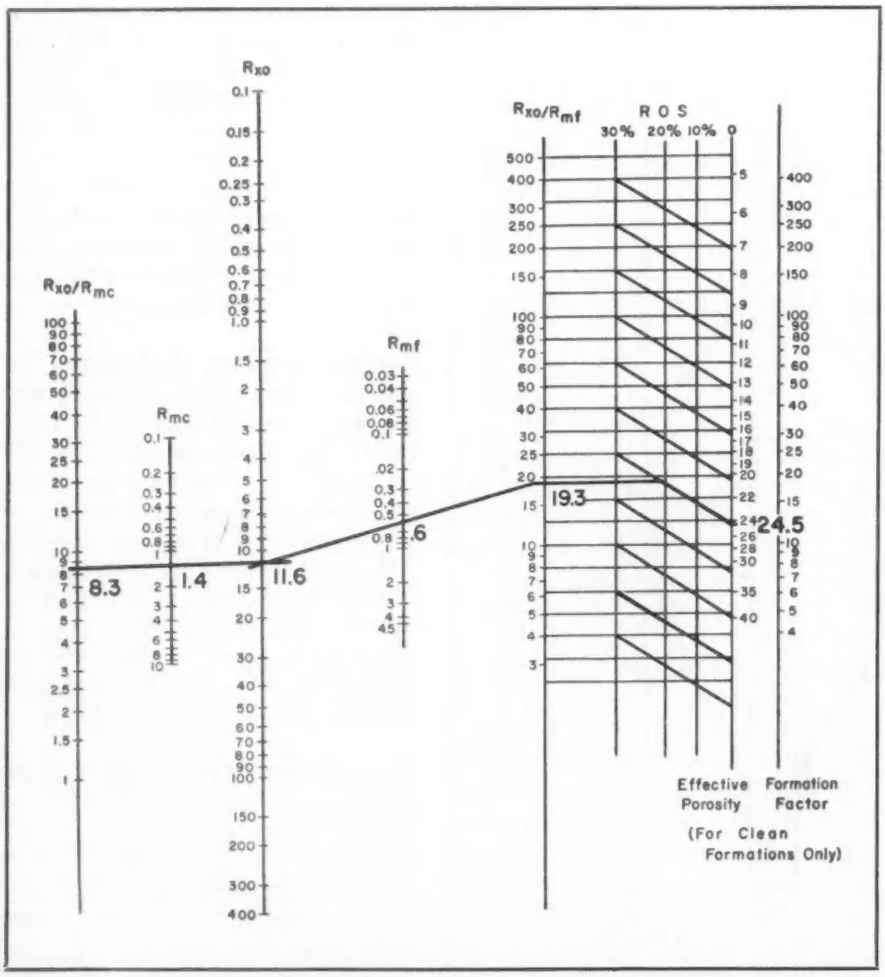

FIGURE 3—A plotting of the Rxo/Rmc ratio on the vertical scale is at left. The next four vertical scales convert this to the ratio Rxo/Rmf which is the formation resistivity factor in clean water sands.

times in literature so it will not be reviewed here. However, the nomographic procedure used in the porosity computations exhibited in this article will be described.

1. Readings from the Contact Log are observed and divided by the mud cake resistivity Rmc. In the example on Figure 2, points are located on the vertical scales and are connected by a straight line.

2. At the point where this straight line intersects the third vertical scale, the ratio Rxo/Rmc can be read. This value has to be corrected for hole size as shown. It will be recalled that Rxo is the resistivity of the zone immediately behind the mud cake. This zone is flushed by mud filtrate of resistivity Rmf.

3. On Figure 3, the Rxo/Rme ratio is plotted on the vertical scale on the left. The next four vertical scales convert this to the ratio Rxo/Rmf which is the Formation Resistivity Factor in clean water sands.

4. The Rxo/Rmf ratio is then converted to porosity by the graphic use of the Humble Formula $F = \frac{.62}{\phi 2.15}$.

5. A residual oil correction is made in oil sands to obtain the final porosity value. Amount of residual oil can be obtained from the analysis of a side wall core.

A similar computation was made at each point where side wall core analysis information was available.

SIDE WALL CORING

History. Side wall cores have been used effectively about 18 years to obtain subsurface data. The method consists in firing hollow bullets into the formation and retrieving the cores thus obtained. Advantages of this technique over conventional coring are twofold:

1. Coring points can be selected after the hole has been drilled.

2. Cores can be obtained from the precise depths desired.

Until recently, however, side wall coring had been restricted to those regions where oil is produced from soft formations, namely, in the Gulf Coast and California. It is only within the last two years that a bullet was designed to cut cores in denser rocks. Following these new developments, the side wall coring technique was introduced in Oklahoma about eight months ago.

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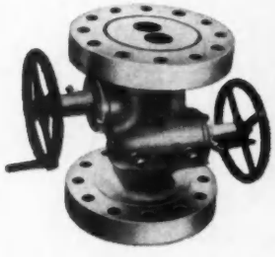
DUAL VALVE



Two valves in one body. Dual completion efficiency is greatly increased and assembly simplified. These valves are available in 2" and 2½" sizes for running two tubing strings in 7" or 8⅝" casing.

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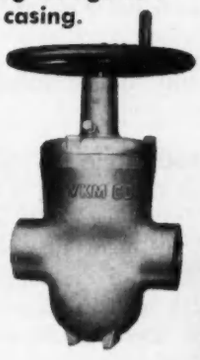
The recessed body permits two parallel strings of tubing to be run in 7" or 8⅝" casing for dual completions when dual valve is not used. Sizes: 2" and 2½". Working pressures: 2000 to 5000 lb. WOG.



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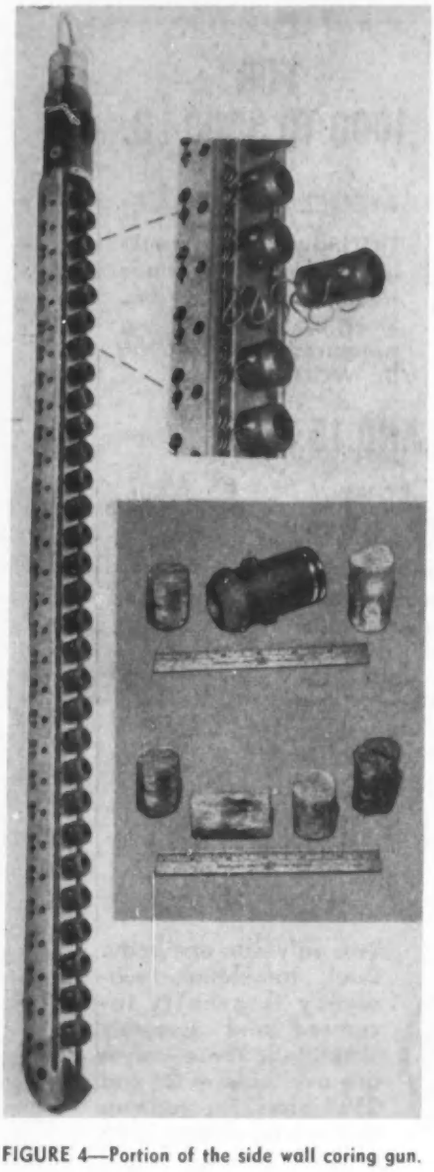

FIGURE 4—Portion of the side wall coring gun.

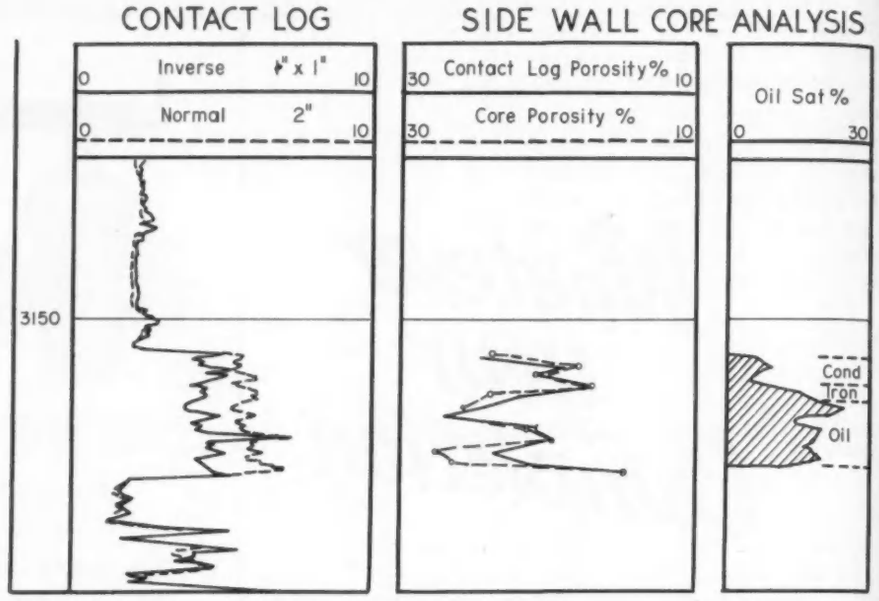

FIGURE 5—Comparison of computed porosity from contact log versus porosity from side wall core analysis. Noble Olson Sand, Chickasha.

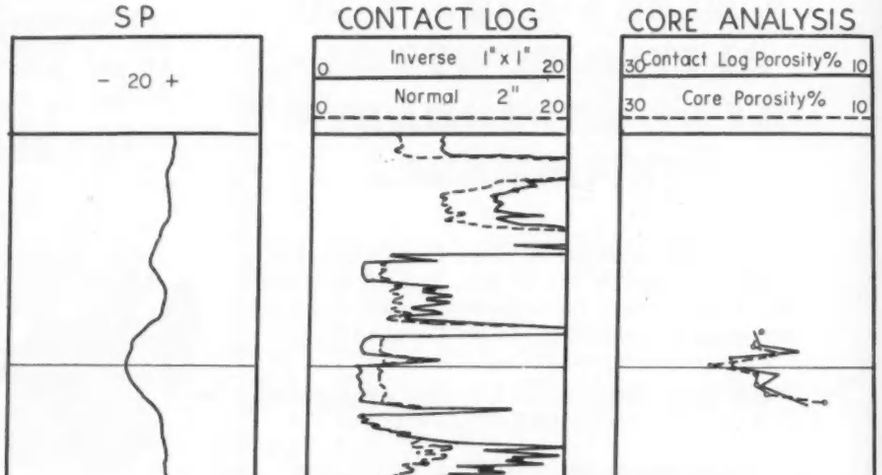

FIGURE 6—Comparison of computed porosity from contact log versus porosity from side wall core analysis. First Deese Sand, N. W. Chitwood.

cored and approximately 800 cores have been recovered.

Field Technique. With the present side wall coring gun, it is possible to obtain from one to 30 cores on one trip in the hole. The cores obtained are ¾ inch in diameter and can be up to 2¼ inch in length. The bullets are fired selectively by electrical ignition of a powder charge. Desired coring points in possible reservoirs can be picked with accuracy from the Contact Log. With this selection, shale and hard streaks can be eliminated easily if desired. Precise depth control is obtained by recording an SP curve on the cable near the gun.

In obtaining a core, the following procedure is followed:

1. The gun is lowered by an electrical cable to a depth near the desired coring point.

2. An SP curve is then recorded and compared with the Contact SP.

3. The gun is then placed at the precise depth where a core is desired.

4. A bullet is fired electrically. Flexible wires allow the bullet to be pulled from the formation by raising the gun.

Figure 4 is a picture of a portion of the side wall coring gun. Several bullets can be seen in the gun with the retrieving wires coiled up beside them. The extended bullet shows the uncoiled retrieving wires and their connections to the gun and bullet.

Core Analysis. All of the side wall core analysis data used in this paper were compiled by a well known core laboratory. Specialized techniques used in the analysis have been developed by them. Successful analysis have been performed on cores ½ inch in length and ¾ inch in diameter.

COMPARISON OF RESULTS

Analysis of Individual Wells. To illustrate the close agreement of porosity values calculated from the Contact Log and those found by side wall core analysis, a plot of the calculated porosities from the Contact Log was superimposed on the regular porosity graph furnished in the side wall core analysis report.

Figure 5 is such a comparison. On the left is shown a section of Contact Log through the Noble Olson Sandstone. This sandstone is of Permian

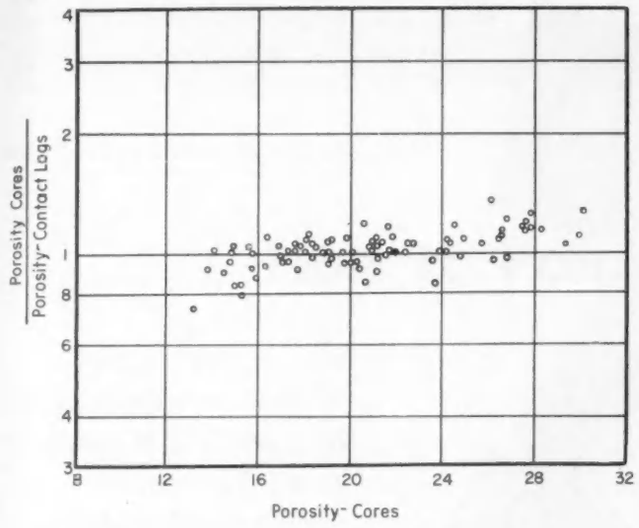

CHART 1 (above)—Comparison of porosity from side wall cores and porosity computed from contact logs. Oklahoma.

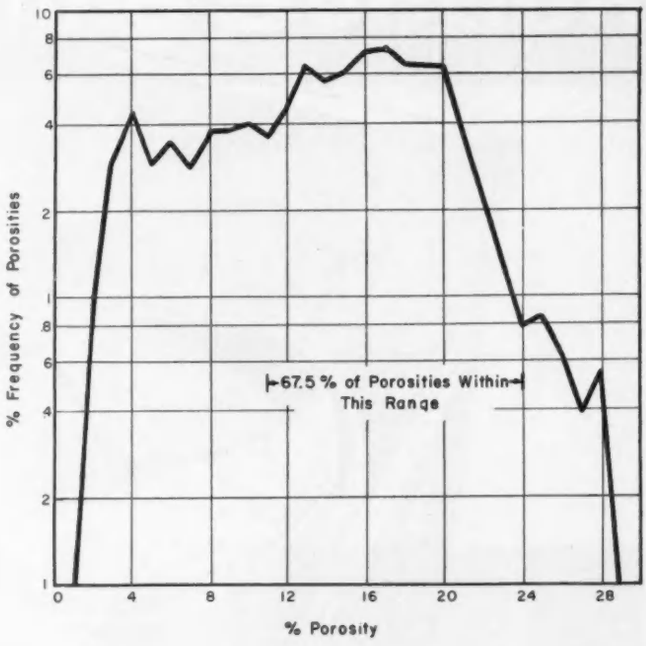

CHART 2 (right)—Porosity frequency of Oklahoma sands and limes.

age and is the main producing horizon of the Chickasha gas field. Side wall cores were taken every foot from 3157 feet to 3178 feet for a total of 21 cores. Length of the cores varied from ¾ inch to 1½ inches. Weight of the samples after cleaning and preparation for analysis ranged from 5.4 to 21.4 grams.

To the right of the Contact Log is a graph of the porosity values plotted every two feet. Scale of porosity increases from 10 percent on the right to 30 percent on the left. For example, at 3157 feet the core porosity was 23.5 percent. This is the first point of the dashed curve. At the same depth, the computed Contact Log porosity was 24.5 percent. This is the first point of the solid curve. Therefore, points connected by the dashed lines are porosities taken directly from the side wall core analysis report. Those connected by the solid line are porosities computed from the Contact Log. The two curves check very well.

The last four feet of the sandstone were cored with a standard core barrel and analyzed. The squares at 3174 feet and 3176 feet are plots of porosity values from the conventional core analysis. These two points fall between the porosity values from the Contact Log and those from the side wall core analysis.

On the right side of the figure is a plot of oil saturations taken from the side wall core analysis. The scale increases from 0 percent on the left to 30 percent on the right. Increase in oil saturations from 3162 feet to 3165 feet was interpreted by the side wall core analysis report as a transition zone from gas to oil.

Figure 6 is a similar comparison. On the left is a section of Contact Log through the first Deese sandstone. This sandstone is of Pennsylvanian age and produces in the Northwest Chitwood field. Side wall cores were taken every 4 inches from 9293 feet to 9307 feet for a total of 36 cores.

On the right is a graph of porosity values plotted every two feet. The scale begins at 10 percent on the right and increases to 30 percent on the left. As in figure 5, points connected by the dashed lines are porosities taken directly from the side wall core analysis report. Points connected by solid lines are porosities computed from the Contact Log. Again, the curves check very well.

Statistical Analysis of Results. Chart 1 is a plot of the ratio of side wall core porosity to computed porosity plotted in abcissa. For example, at one point where the core analysis porosity was 19.8 percent, the Contact Log computed porosity was 18.0 percent. Ratio of the core porosity to Contact Log porosity is 1.1. This ratio was plotted opposite 19.8 percent.

Porosity values used in making up the chart were taken from six wells and over 100 side wall cores. Formations represented are the Fortuna, Noble Olson, Garber and Herington of the Permian period, and the Burling, Layton, First Deese, Marchand and Skinner of the Pennsylvanian period. Grouping of points over the entire range is excellent. Of course, if the porosity values checked each other perfectly, the ratio would be one in all cases. In the higher ranges, that is above 26 percent porosity, core analysis porosities tend to be greater than those calculated from the Contact Log.

To find out range of porosities most frequently investigated in Oklahoma, about 1300 actual core analysis values were picked at random from porous sandstones and limestones of the state. Number of times that each porosity appeared was tabulated. Chart 2 is a plot of the percentage of the total appearance in ordinate against the porosity in abcissa. This chart shows that 67.5 percent of the cores investigated are in the porosity range from 11 percent to 24 percent. Referring to Chart 1, it can be seen that the best agreement between the porosities from the Contact Log and those from side wall cores falls within this range.

ACKNOWLEDGMENT

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Acknowledgment also is due the oil companies who provided data and released the logs for the illustration of this article.

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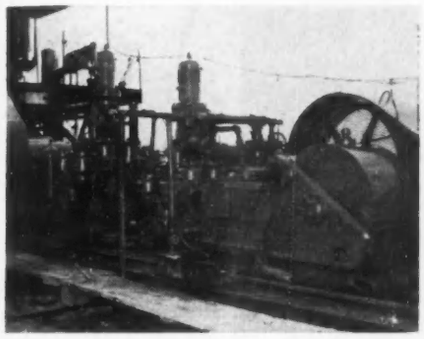
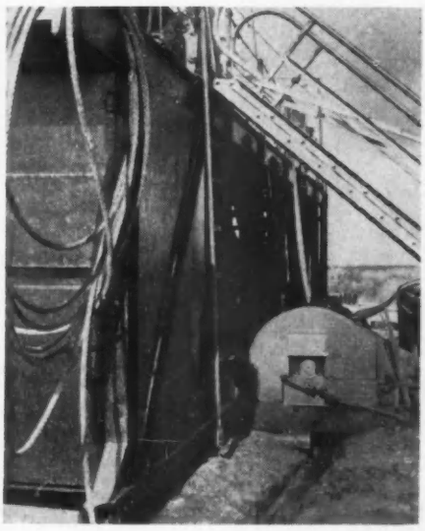
Special Report on Corrosion

How to Paint a Drilling Rig

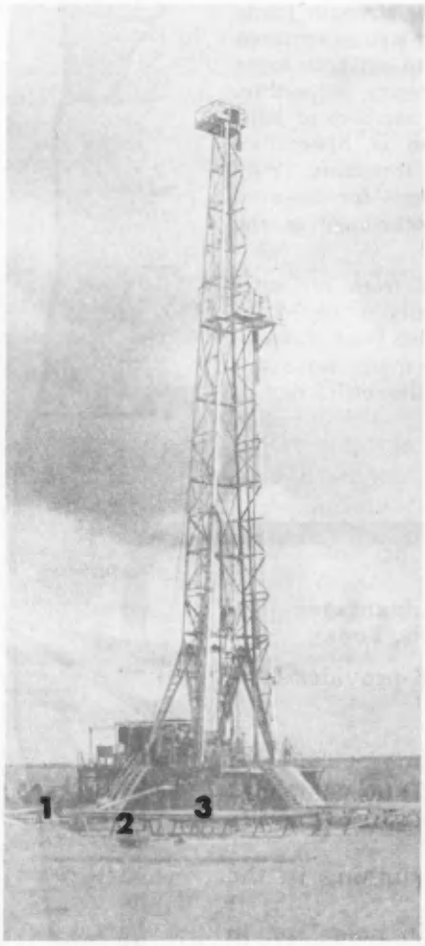
What coating to use for a given application and what results can be expected.



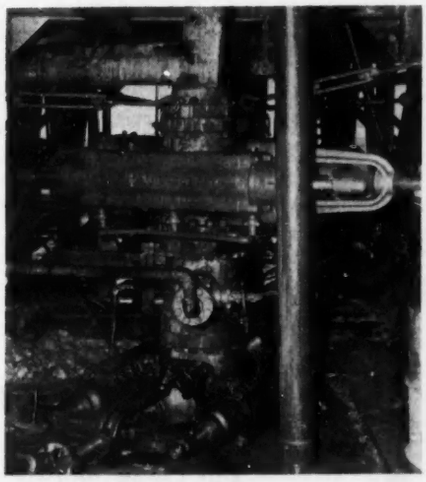
1—Mud pumps on drilling rig showing the use of specially formulated epoxy-ester type coatings after months of rigid service. In specific areas where this equipment operated high pH muds are necessary, yet coating has given outstanding service.



2—Substructure and winch on a rig. Winch is coated with epoxy-ester type coating and structural members with Butadiene-Styrene type coatings, actually proven in the field. Note severity of conditions in immediate area. Substructure members are free of corrosion after seven months in field. This structure had been moved five times over considerable distance at this time.



Entire rig and derrick is protected from corrosion attack by specially formulated finishes. This equipment has been used for actual testing area under field conditions.



3—Blowout preventers saturated with high alkali drilling mud at elevated temperatures. Conditions like these strip ordinary paints in one day, these preventers have been on five holes in seven months and still show no corrosion. Only failure in surface coat has been from scarring with chains when moving to new locations, prime coat is still intact. Note mud splashed on main structural beam over head and on supporting members, yet gloss is still high on preventers, even on lower one in cellar in direct contact with high alkali drilling mud.

By JOHN W. NEE
Vice President and Technical Director
Briner Paint Manufacturing Company
Corpus Christi, Texas

ONE OF THE most important factors in the protection of any substrate with paint or other surface coating is the selection of the proper coating material for that particular surface. A series of guide posts can be used to help in the selection of the proper coating for any specific function. In almost every case the selection will be in the nature of a compromise; to pick the best possible coating for the surface in question, yet fit into the various facets of application and service.

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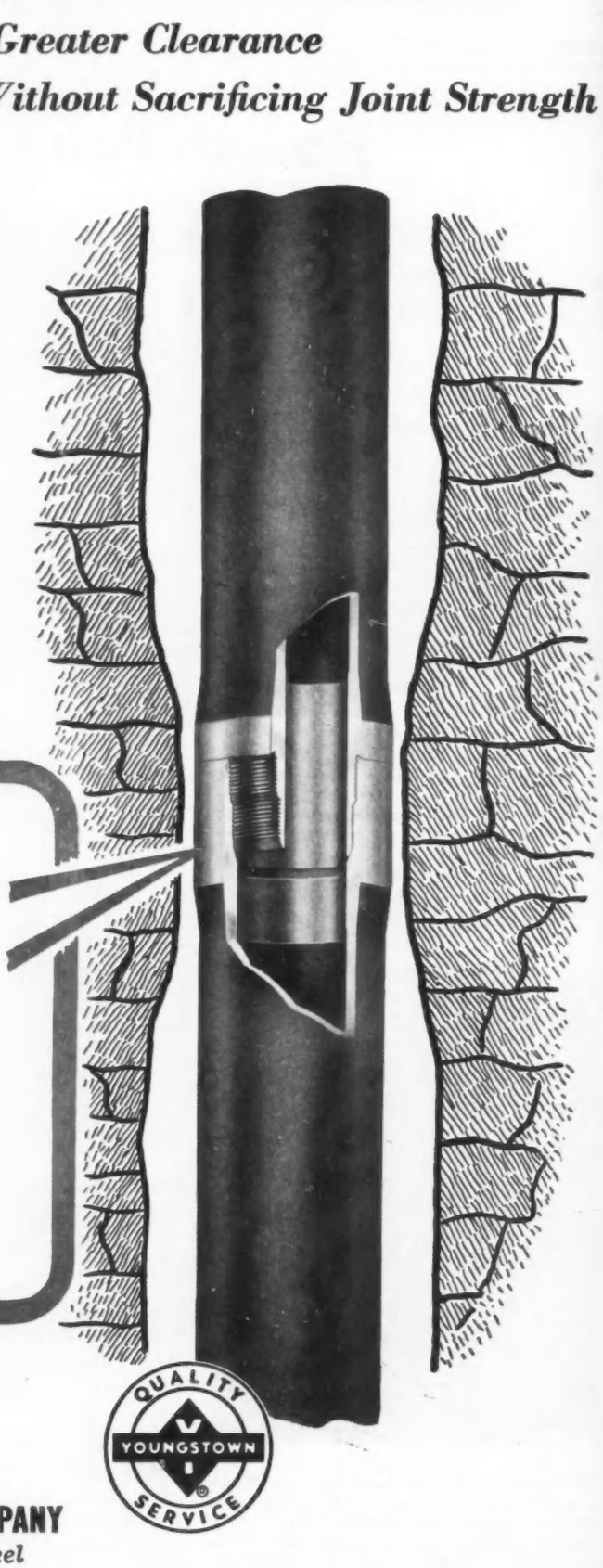

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application, the reasons it is selected, and what to expect from the coating when exposed under the conditions outlined. The advantages and disadvantages will be pointed out. Desired qualities will be balanced against conditions of the job, cost, time element and application methods. Alternate steps will be shown whenever indicated by changes in these conditions.

The selection of the coatings for a given application must consider which coating is most adaptable to the particular and peculiar service and attempt to balance out the weak points of the coating and the application procedure. What can be used to obtain the following?

- The greatest amount of service.
- The longest life.
- The highest degree of protection from corrosion.
- Practical economics.

Can it be applied in the location in question in the manner required to yield all these qualities?

As an example, it has been decided that a vinyl-based coating will yield the best results on acid pumps. Yet, because of the close proximity to operating motors, the surfaces cannot be sandblasted. The best results in vinyls are obtained by application over sandblasted surfaces. Therefore, the decision whether to use a vinyl based coating over a hand cleaned surface or not must be made. Should durability be sacrificed due to loss of adhesion and under film corrosion? Or, should a coating more adaptable to non-sandblasted surfaces be selected? The latter would be cheaper to apply, require perhaps fewer coats, and of course, have a much shorter service life. It would probably give protection on a stand-by basis until the time when a shut down occurs. Then the pumps can be removed to an area that will allow for sandblasting and the proper application of the best known coating for the job. At this point a vinyl mastic might be selected and only one coat used. A high solid chlorinated rubber might be decided on, or to do a real cheap economical job, an asphalt or asphaltic mastic might be used for temporary protection.

Here are the conditions to be considered in the selection of any surface coating:

- **Type of surface**—What is the substrate to be coated, metal, wood, plastic, masonry—what kind and type, and in what conditions?

- **Method of surface preparation**—Sandblast, hand clean, mechanical cleaning, chemical cleaning. Which is feasible and which fits into the conditions of the particular location?

- **Conditions of exposure**—Atmospheric, chemical fume or spillage, mild or strong, solvents, temperature, wet or dry, immersion. Are conditions constant or intermittent, and are they the same in all seasons of the year?

- **Methods of application**—Spray, brush, or roll coat. Which is allowable by conditions?

- **Time**—Time of dry, time to recoat, how long before it's available for use? How long before men can work with it or around it without damage to coating or their clothes?

- **Cost**—Management's prime interest, and it must fit the situation. Should be figured on the cost per square foot per annum on long term applications, and job wise on temporary protection.

What are the materials usually used by the surface coating formulator to obtain these results and what are their most common physical characteristics?

- **Oleo-Resinous Coatings**—The product of a resin and oil varnish—hot cooked or cold blended; i.e., phenolic resins (pure and modified), ester gums (glycerol or pentaerythritol), resin, and other hard resins.

- **Combined with vegetable drying oils**—Properties: Low cost, ease of application (any method), usually slower drying, low chemical resistance, fair water resistance (non-immersion), good weather resistance, poor solvent resistance, and poor heat resistance.

- **Alkyd Resin Coatings**—There are a complex family of resins generally composed of glycerine or Pentaerythritol-Phthalic anhydride (or Maleic, fumaric, or others) esters, modified with the esterification product of drying oil fatty acids.

Properties: Medium to low cost, ease of application (any method), medium drying speed, low chemical resistance, fair to medium water resistance (non-immersion), good to excellent weather resistance, fair solvent resistance, and low heat resistance (not over 200° F.).

- **Vinyl Resin Coatings**—Pigmented solutions of Vinyl Copolymers that dry by evaporation of the solvent phase.

Properties: Medium to high cost, limited application (usually only by spray), fast drying, low solids—multiple coating required, excellent chemical resistance, high water resistance (under 165° F.), excellent weather resistance, and good resistance to aliphatic solvents and alcohols, none to ketones, softens with aromatics—dry heat to 250° F., wet heat to 165° F.

The most universal chemical and weather resistant coating when properly formulated and applied.

- **Chlorinated Rubber**—A product of the Chlorination of pure natural rubber latex, approximately 65 percent chlorine. Dries by solvent evaporation. Properties: Medium cost, limited application (usually sprayed, can be brushed with limitations), fast drying, medium high solids, excellent chemical resistance, good water resistance (up to 165° F.), excellent weather resistance, fair resistance to aliphatic solvents, none, to aromatic or ketones, and dry heat to 250° F., wet to 165° F.

An excellent chemical and weather resistant coating usually requiring only 3-4 coats for maximum protection.

- **Epoxy Resin Coatings**—A resinous product of the reaction of Epichlorohydrin and bis-phenol.

Class 'A'—Amine cured Epoxy resin coatings, which dry by evaporation of solvent, but cure or convert by action of amine catalyst added immediately prior to application.

Properties: Medium to high cost, limited application (mostly by spray, can be brushed with limitations), medium to fast drying, high chemical resistance, high water resistance (up

to 200° F.), excellent weather resistance (chalks rapidly), excellent resistance to most aliphatic and aromatic solvents, dry heat to 400° F., wet to 250° F., high solids, and excellent abrasion resistance.

• **Class 'B'—Epoxy Resin**—Oil fatty acid esters, air drying coatings which dry by oxidation.

Properties: Medium cost, ease of application (usually all methods), medium to fast drying, mild chemical resistance, good water resistance (non-immersion), excellent weather resistance, and good resistance to aliphatic solvents, poor to all others, dry heat up to 200° F., wet to 160° F., high solids, and good abrasion resistance.

Excellent for machinery, decks, floor plates, concrete, where good abrasion and mild chemical resistance is required.

• **Butadiene-styrene copolymers**—A rubber like reaction product of butadiene and styrene. Drys by evaporation of solvents only.

Properties: Medium cost, fair application (spray or brush with limitations), fast drying speed, high chemical resistance, good water resistance (non-immersion), good weather resistance, *no solvent resistance at all,* high heat resistance—dry to 800° F. indoors, wet to 250° F., medium solids.

An excellent coating for concrete floors, wet storage tanks. Also used inside as a high heat aluminum for boiler breaching, doors, etc.

Having set up the guide posts, let us consider the actual usage of them in charting a program of protection and decoration for the drilling industry. For many years, the oil field operators and many paint producers considered that since oil field equipment was handled so roughly, that only temporary protection was needed, as long as the colors were bright. Considering that the rig would be skidded across the road to an offset, or trucked 200 miles away for new locations, the theory was that almost any hard drying gloss coating would do. It was going to be ruined by handling anyway. However, in more recent years the coating technologist has become more aware of the driller's problems. The driller himself has demanded better protection, particularly against the chemicals used in drilling.

Let us assume we have a derrick and substructure, two blowout preventers, and are using a high caustic mud. Ordinary paint would last about one day before main beams and all safety equipment on the underside of the substructure would be stripped of paint and starting to corrode rapidly.

What do we use to prevent this? We are on location and it is difficult and costly to move sandblast equipment in. Probably the drilling crew will be used to paint. Painting must be done over old paint, on a hand cleaned surface, dry rapidly, and give the best protection with the least number of coats. The Oleo-resinous and alkyd base coatings will not take the caustic in the mud. Vinyl coatings require sandblasted surfaces, do not work well over old paint, (except where detailed special systems are used also), do not brush well, and require too many coats.

Epoxy systems should be used over sandblasted surfaces for best results. These too, are poor brush material and require special additives on the job. Epoxy esters do not have the chemical resistance needed because of the modification with oil fatty acids.

So we have only the chlorinated rubber and butadiene-styrene coatings left. Of these, the chlorinated rubber contains a much higher content of aromatic solvents. Whereas the butadiene-styrene coatings can be thinned with a higher aliphatic solvent content. Both have fair brushing properties, so our own drilling crew can apply them. Each will spray if we have spray equipment. Each has a high solids content, so one brush coat of primer and one finish coat can yield a coat 3 mils thick or better.

No special surface preparation is essential. Butadiene-styrene is weak in solvents, but not so weak that it will not resist daily clean-up and wipe down with kerosine that the crew will normally use. So we can use either coating for this job.

What are the results? On such equipment as this, painted with just paint every time it reached a new location, we have seen the main beams eaten through, and requiring replacement in less than one year. Blowout preventers were so corroded it was problematical whether they would work properly if called on in an emergency. The shale-shaker was practically destroyed and constantly being patched.

When a butadiene-styrene coating was applied by brush over hand cleaned, scraped and wire brushed surfaces, it was possible to drill five wells in seven months with only touch-up repairs before the equipment needed to be repainted. No corrosion damage had occurred and everything was in fine preservation.

These five wells were in a radius of 200 miles. One well was on a fresh water lake bank, and one, a directional hole was on the edge of a salt water bay. Almost every condition had been met with and protection was good. The mast was also protected in this way, and was not corroded from mud splash. It was in equally good condition after a particularly messy acid swabbing chore.

If this derrick and sub-structure could be sandblasted and a full system applied, vinyl, Epoxy-amine chlorinated rubber, or butadiene-styrene coatings could be used, they would be chosen in about that order of quality. On location patch the breaks (mechanical, handling) with butadiene-styrene as it is most adaptable to field use, while offering the best of properties under a compromise situation. —**The End**

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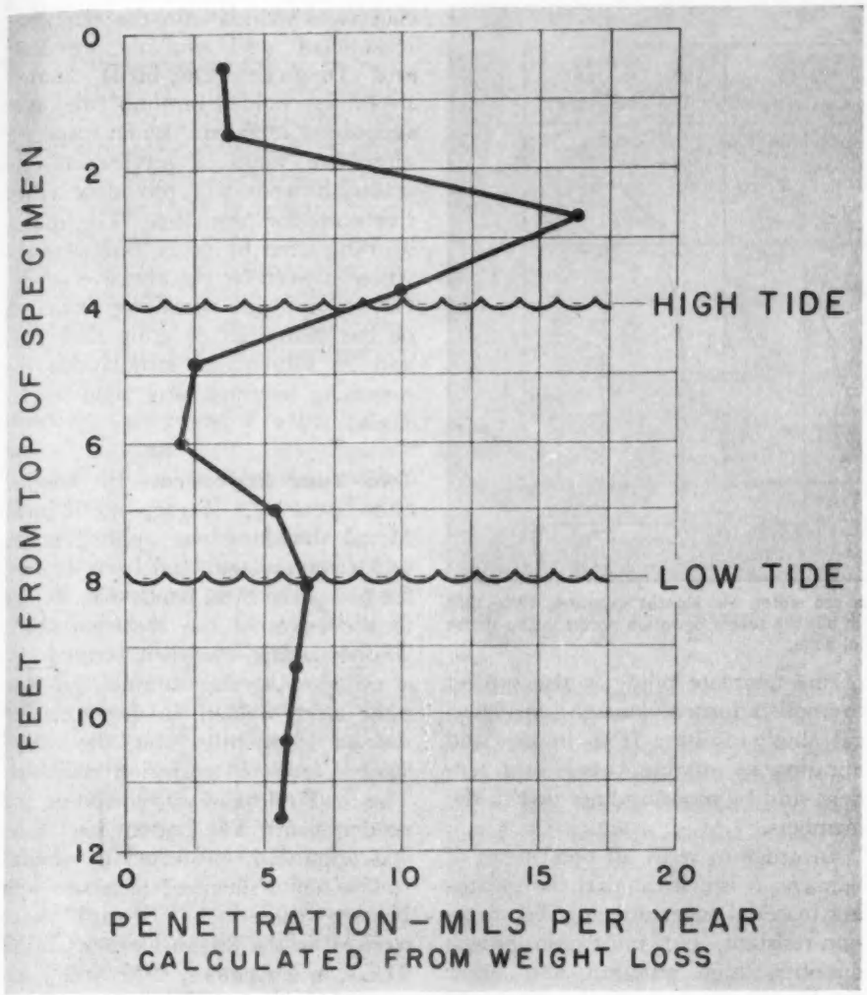

FIGURE 1—This graph illustrates the corrosion rate of steel pilings partially immersed in sea water. The graph covers the area from 4 feet above high tide to 4 feet below low tide. Note the severity of corrosion attack in the splash zone.

Special Report on Corrosion

Splash Zone Protection For Offshore Structures

The area just above the mean tide level is the most critical from a standpoint of corrosion protection.

By BYRON B. MORTON
The International Nickel Company, Inc.
New York City

When the petroleum companies extended their drilling operations into offshore locations, they entered a region of intense salt water corrosion. It soon became apparent that, while all parts of the offshore drilling structure must be protected from corrosion, the problem was particularly acute in the splash zone—the area just above mean tide level which is intermittently wetted by tides, swells and spray.

In the intervening years, Monel nickel-copper alloy has been widely used as sheathing material in this critical zone and has proved to be a highly resistant metal shield. While sheathing with this corrosion-resistant alloy has become generally accepted as an effective method of protection, there has been less unanimity of opinion concerning ways and means of applying it. The situation is more fluid with respect to suitable gage or thickness, methods of attaching the sheathing to the parts requiring protection, the proper time to apply the sheathing, etc. A review of some past installations and a discussion of present trends may help to standardize procedures and point the way to the most economical utilization of this method of protection.

Protection of other portions of the structures is relatively simple. The area remaining permanently under water can be economically protected by applying induced current to the parts. Effective cathodic protection is afforded by impressed current or current from sacrificial anodes of magnesium, aluminum or zinc, suspended below low water level. The cable used to support the anodes must be strong enough to withstand the pounding action of waves upon the anodes, and at the same time capable of resisting the intense corrosion at the water level. The requirements of good strength and corrosion resistance have directed attention to Monel cables, and a substantial footage has been installed.

Corrosion Above Splash Area. Above the splash area, the corrosive conditions are similar to those encountered by the decks and superstructures of ships, and experience has shown that hot dipped galvanizing and the use of paint will adequately protect the steel.

The area within the splash zone,

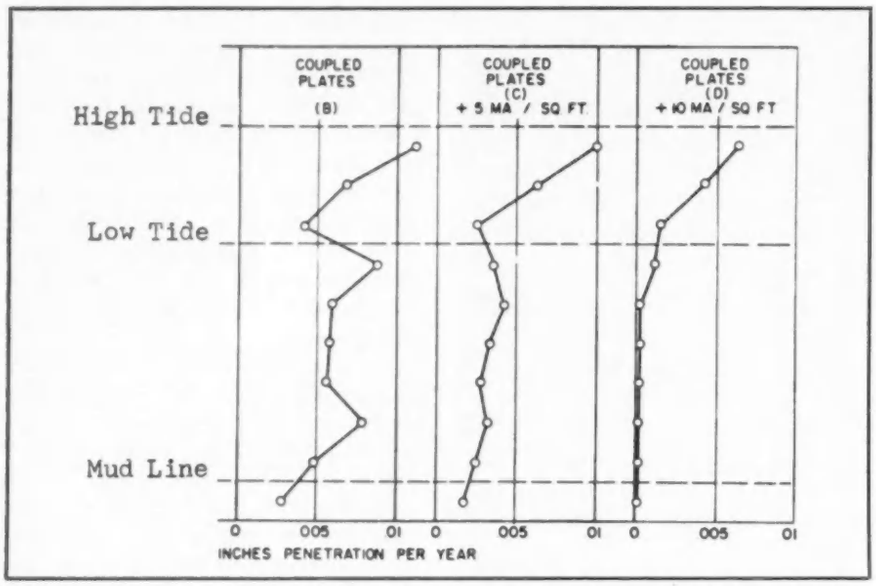
COUPLED PLATES (B)
COUPLED PLATES (C) + 5 MA / SQ FT
COUPLED PLATES (D) + 10 MA / SQ FT
High Tide
Low Tide
Mud Line
0 005 01 0 005 01 0 005 01
INCHES PENETRATION PER YEAR

FIGURE 2—Corrosion rates of mild steel plates in sea water. Six months exposure. Note that corrosion below the low water level can be controlled, but the severe corrosion occurs in the splash zone and tidal zone.

however, presents a real problem. It is extremely difficult, if not impossible, to renew paint or other coatings in this area successfully. The absence of continuous electrolyte precludes the use of current, and experiments showed that zinc coating failed to provide satisfactory, permanent protection.

Figure 1 will serve to illustrate the varying rates of corrosion to which different parts of unprotected steel structures standing in sea water are subjected. Note that the portion most severely attacked is the splash zone above high tide. Table 1 is a comparison of corrosion rates of wrought iron, and steel with varying percentages of copper and also of monel in a marine atmosphere.

Figure 2 makes it clear that the corrosion occurring below the low water level can be controlled by impressed current but that cathodic protection is not effective in the tidal zone nor, of course, in the splash zone above it.

Mechanical Abuse. The splash zone of the template piling is also subject to another form of damage—mechanical abuse resulting from impact and abrasion by marine vessels and tenders, and by mooring lines tied to the members.

In order to resist all these types of damage, it is evident that the sheathing material must not only be corrosion-resistant, but must also possess ductility, high strength and other good mechanical properties. It should be easily fabricated and welded. Table 2 lists the properties of Monel applicable to the requirements of this service.

Before going into methods of applying the sheathing, it may be helpful to review briefly some of the installations that have been made, and examine the endurance of the sheathing and the effectiveness of the protection afforded.

One of the earliest installations was fabricated ashore in July, 1949, and set in the water three miles off the Louisiana shore in August of that year. Three different types of protection were used: 20 percent Monel-clad steel welded into the template; nickel-clad steel similarly installed; and 16-gage (.062-inch) Monel sheathing welded around the steel supporting members. When inspected after five years of service, all the materials were still providing effective corrosion resistance. The metals were battered by boats, but were nowhere pierced by the abrasive action. Cost of applying sheathing proved to be less than that of using clad steel, and in subsequent installations the sheathing method was used exclusively.

Two Year Exposure. In another case nearby, 16-gage (.062-inch) Monel sheathing was applied at sea to a structure that had been exposed for two years. Steel bands were welded to the edges of the sheet on shore. The sheathing was then formed into a cylinder, sprung around the template and welded in position. Inspected 18 months later, the Monel showed expected corrosion resistance. The top steel band was corroding and needed paint. The bottom steel band was apparently protected by anodes.

Two units sheathed on shore with 16-gage (.062-inch) Monel sheet were set in the Bay of Corpus Christi, Texas, in November, 1952, and January, 1953. Inspected in June, 1954, both units were found to be in excellent condition.

A 10-inch H-beam pile sheathed with 18-gage (.050-inch) Monel sheet was installed in the bay off Galveston, Texas, in April, 1953. A magnesium anode was used for underwater protection. Depending on wind conditions, the sheathing was sometimes submerged, sometimes entirely exposed. Recent inspection disclosed the sheathing to be in very good condition.

One installation made at sea on an existing structure in July, 1953, involved applying sheathing to a large number of structural braces and supports as well as to the vertical members. While the material was success-

TABLE 1
Corrosion Test Data—Marine Atmospheres

LOCATION	MATERIAL	Years Exposure	Corrosion Rate—IPY
Kure Beach, N.C.—(800 Ft. Lot)	Steel (0.03% Cu)	7.5	0.0027
Kure Beach, N.C.—(800 Ft. Lot)	Steel (0.21% Cu)	7.5	0.0017
Halifax, N.S.	Steel (0.07% Cu)	15	0.0017
Plymouth, England	Steel (0.07% Cu)	15	0.0046
Kure Beach, N.C.—(800 Ft. Lot)	Wrought Iron (0.01% Cu)	7.5	0.069
Kure Beach, N.C.—(800 Ft. Lot)	Wrought Iron (0.29% Cu)	7.5	0.0023
Halifax, N.S.	Wrought Iron (0.02% Cu)	15.	0.0022
Plymouth, England	Wrought Iron (0.02% Cu)	15.	0.0093
Kure Beach, N.C.—(800 Ft. Lot)	Monel	4.	0.00002
Eastport, Maine	Monel	5.	0.00003

TABLE 2
Mechanical Properties of Monel Alloy

Form and Condition	Yield Strength (0.2% Offset) in 1000 psi.	Tensile Strength in 1000 psi.	Elongation in 2 in. Percent	Hardness Brinell
Annealed	35	75	40	125
Hot-rolled	50	90	35	150
Cold-drawn	80	100	25	190
Cold-rolled	100	110	5	240

fully fitted and applied and afforded the desired protection, the complex form of the structure made the project expensive. In many of the older structures little consideration was given to problems involved in applying splash zone corrosion protection. Today the tendency is to place braces and supports either under water where they can be protected by impressed current, or well above the water level (see Figure 3) where they will not complicate the sheathing of the verticals.

Effective Corrosion Protection. It appears obvious from these inspection studies that the Monel sheathing has provided a high degree of corrosion protection and has exhibited adequate resistance to mechanical damage. A projection of results to date clearly indicates that any thickness of the sheathing material that can be applied satisfactorily, and that is heavy enough to withstand the mechanical abuse will continue to afford adequate corrosion protection during the desired life of a structure.

Until recently, it was felt that producing wells should be brought in before any elaborate protection of the structures was warranted. Examination of comparative costs of sheathing on shore during fabrication and applying the sheathing to structures standing in the sea after a period of exposure has recently led to a reevaluation of procedure. Since it is much more economical to sheathe on shore, and since the cost of applying the protective covering is so small compared to the total cost of the structure, a number of operators are now applying the sheathing on a routine basis to all new platforms before they are set in the water. The trend is definitely in this direction. (Figure 4)

On all of the early installations, 16-gage (.062-inch) sheet was used on all members in the splash zone. Subsequent practice has been to use 18-gage (0.050-inch) sheathing except where need for unusual resistance to mechanical damage is indicated. In the interest of economy, some work has been done using even thinner gages.

Welding to Attach Sheathing. Welding continues to be the favored method for attaching the Monel protective covering to the steel tubular members. In the case of new construction, the sheet is welded directly to the tubing, without using bands or strips at the edges. When the covering is applied at this time, it can be welded to the tubular members before they are assembled into templates. The tubing lies horizontal and downhand welding positions may be used. This facilitates the use of the No. 140 Monel-to-steel electrodes, permitting easy handling and assuring sound welds.

When attaching the sheathing to existing structures at sea, it is frequently advisable to weld steel bands of, say, 14-gage (.078-inch) to the edges of the sheet, using No. 140 rod. The finished sheathing is then formed to the desired curvature, sprung over the tubing, and welded in place.

The use of the steel bands on old structures offers several advantages:

1. Steel welding electrodes may be used to apply the sheathing to the

FIGURE 3—An eight-pile jacket-type marine drilling platform, sheathed with Monel in the splash zone. Note that cross-bracing has been placed high out of this hard-to-protect zone.

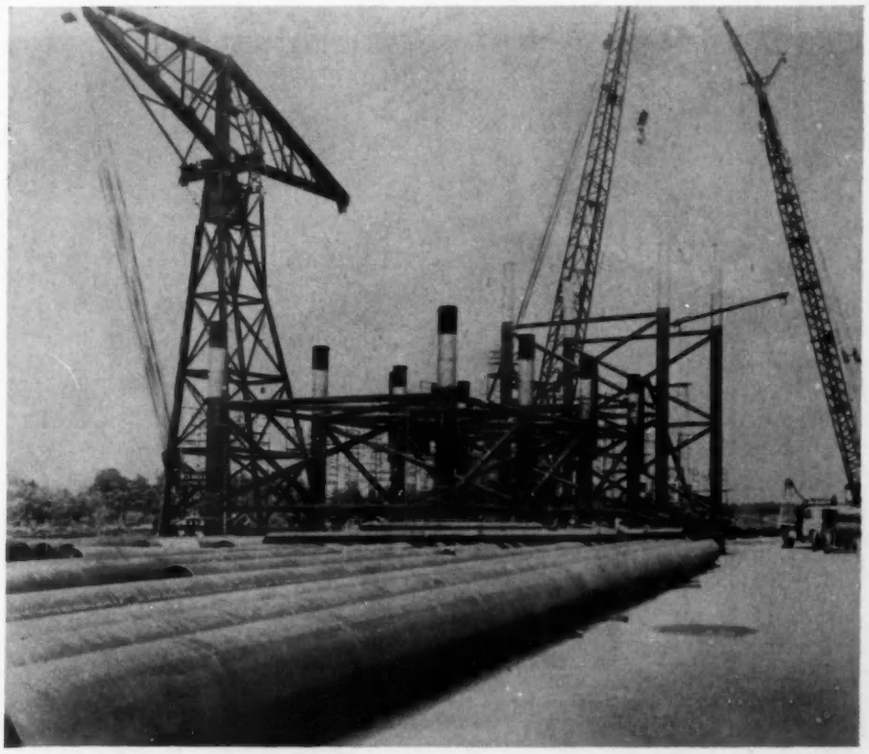

FIGURE 4—Two drilling platforms, shown under construction in the yards of Brown & Root, Inc., have been sheathed with 18-gage Monel sheet in the splash zone. Vinyl coatings or other organic protective materials are then applied to higher areas of piling.

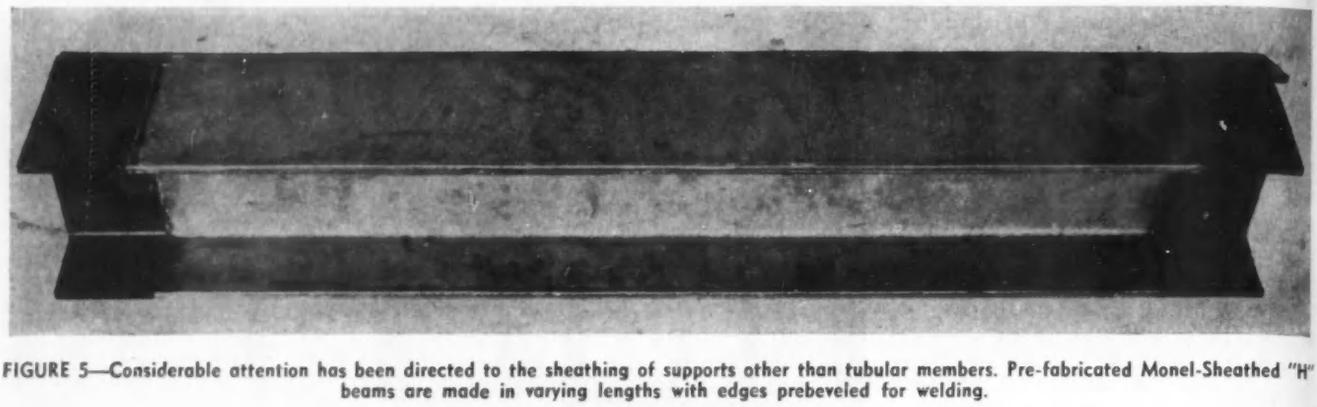

FIGURE 5—Considerable attention has been directed to the sheathing of supports other than tubular members. Pre-fabricated Monel-Sheathed "H" beams are made in varying lengths with edges prebeveled for welding.

structure. This is an important factor where other than downhand positions are used.

2. When welding sheathing to an existing structure there is danger that lead, mercury, sulfur or some other harmful elements may be present as the result of previous painting. Such elements would tend to embrittle and crack that part of the Monel sheathing heated to welding temperatures. The steel bands are not subject to this form of attack.

3. Where heavy galvanizing exists on a structure, the steel electrodes burn through it more readily, and the welding operation may be completed in less time.

Upper and Lower Bands. When using the steel bands, the lower band should lie in the region which is electrolytically protected. This location will usually be at mid-tide level. The upper band must be galvanized, zinc sprayed or painted for protection.

Despite the general preference for welding, the search continues for other practical methods of applying the sheathing. The use of studs and other mechanical fastenings has been suggested, but there is decided objection to any fastening that enters the steel tubular members. If the tubing should be penetrated, air admitted inside the template would accelerate corrosion of the piling that supports the large drilling structures.

A wrapping method that avoids the use of welding has also been studied. In this method a thin 24 gage (.025-inch) sheet is used, held in place by bands of Monel using regular clips. The steel member is coated with a coal tar enamel for a uniform thickness of about 1/16-inch. The Monel sheet is wrapped over the coated area and made to fit snugly by means of clamps. Successive wrappers are overlapped about one inch. The retaining bands are then applied, spaced about 12 inches apart. The banding used in this experimental project was 3/4-inch wide by .032-inch thick, and was equipped with 3/4-inch buckles.

Other Offshore Structures. Protective Monel sheathing has also been applied to offshore structures other than drilling platforms. The application to tank battery barges is similar to that for platforms and requires no special comment.

Monel sheathed H-beam sections are now made by a number of fabricators for use in piling of inshore docks and piers. The new type structural shape is available as a standard 11-foot H-beam section, sheathed in the center portion for a distance of ten feet (Figure 5). Other lengths can be supplied on special order. Six inches of bare steel is left unsheathed at each end, and edges are prebeveled for welding. Ordinary H-beam piling is driven close to final footing and if necessary, cut off slightly above mean tide level. Then the sheathed section is welded on and driving continued to final footing.

Protection of mobile drilling barges requires extensive use of sheathing to protect areas exposed to splash and air. Due to its mobility and method of operation, it requires protection on a spray zone which might vary to the extent of 50 or 55 feet, Figure 6. On the first drilling barge to employ Monel protection, the descending tubular members were sheathed for a length of 55 feet, to provide corrosion protection throughout the entire range of operating conditions. —**The End**

FIGURE 6—This submersible drilling barge, designed to operate in 75 feet of water, has a spray zone which may vary to the extent of 50 to 55 feet. The caissons and diagonal supporting members have therefore been sheathed with thin gage (0.031 inch) Monel sheet to a height of 55 feet. The barge was built by Avondale Marine Ways, New Orleans.

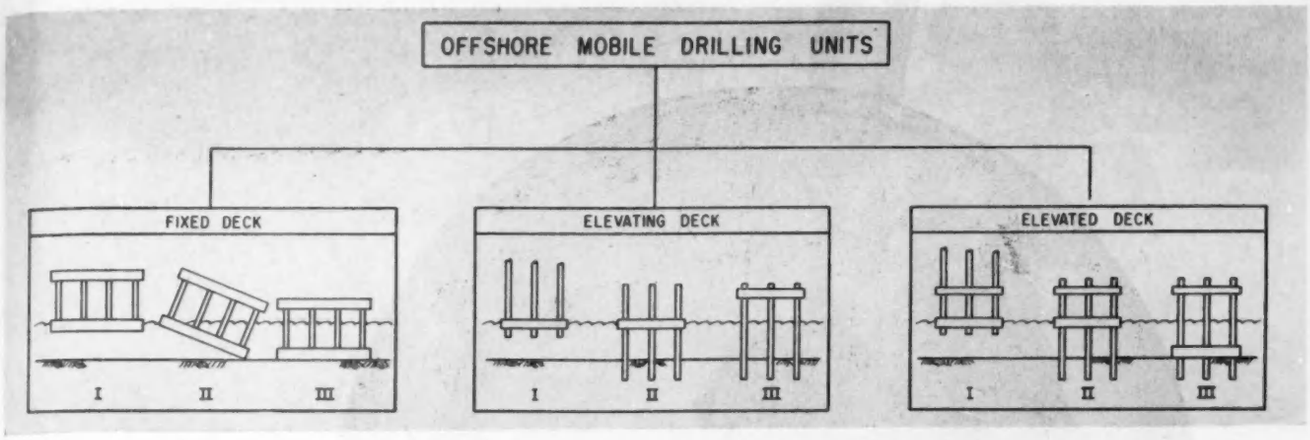

FIGURE 1—Classification of offshore mobile drilling units.

Special Report on Corrosion

Mobile Platforms Get Cathodic Protection

Protection against salt water corrosion for the hull and supports of mobile units is running approximately 3 to 4 cents per square foot per year.

By E. P. DOREMUS and JACK G. DAVIS
Cathodic Protection Service
Houston

THERE ARE many problems inherent in offshore exploration and drilling such as platform design, and the operation and logistics of the platform. Combating of corrosion on the thousands of tons of steel equipment which has gone into the construction of the platforms proper and all of the attendant facilities, has been one of the most critical problems resulting from the invasion of the offshore field by oil operators. The corrosion of steel piling, both in the atmospheric and submerged zones, has long been observed in the steel pilings of bulkheads and piers. Attempts to combat corrosion in these zones, in past years, have been rather spasmodic. At the outset of the offshore program, it was recognized that corrosion in either zone could not be tolerated for any length of time without disastrous results. Although there was no great experience on which the industry could draw for the protection of either zone, steps were initiated to at least minimize corrosion in both these zones.

Mitigation of corrosion in the atmospheric zone can best be combated through the use of corrosion resistant metal sheaths or the use of coatings, with improved application techniques. This phase of the offshore corrosion mitigation is not within the scope of this paper.

Cathodic protection for corrosion inhibition of the submerged zone of steel piling had not been too wide spread at the start of the offshore program. Cathodic protection could be relied upon to arrest corrosion practically 100 percent in this zone. It remained only to develop suitable techniques for its application to the offshore platforms. One of the authors was active in placing under protection the first offshore platform of the stationary type to which protection was applied. An earlier article[1] presented techniques developed for the protection of this first platform. These techniques have subsequently been used successfully to protect over 100 similar structures, representing a combined total of over 4 million square feet of submerged surface. All of the early installations used magnesium anodes, exclusively, as a source of protective current. Electrical power was usually not available during the early stages of operation of these platforms. As offshore fields have been developed, power has been made available at some of the stationary platforms. Power transmission lines from shore have been constructed or power has been generated at the platform. In some of these cases it has been possible to substitute rectifiers and graphite and Duriron anodes as a source of cathodic protection cur-

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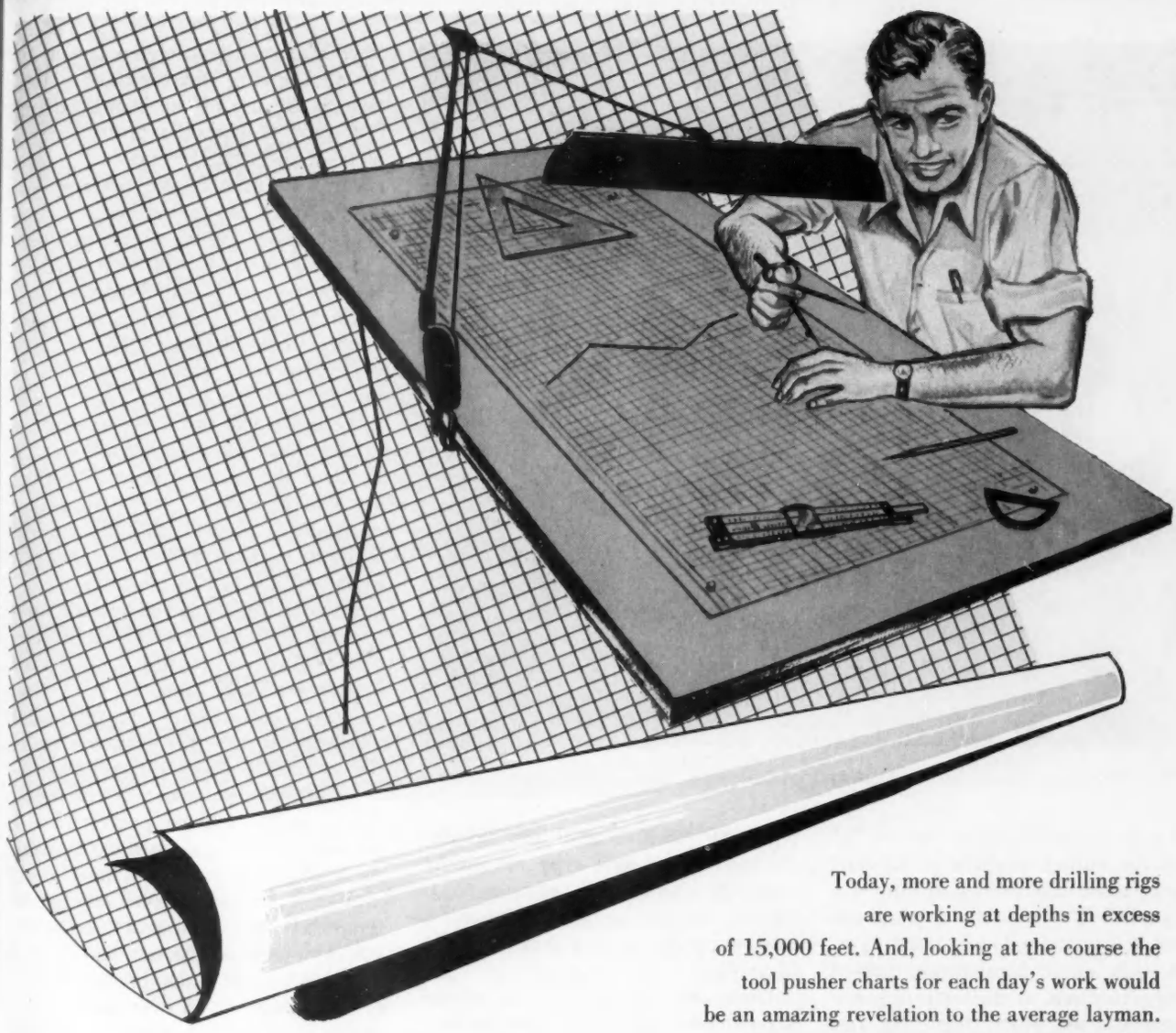

Charting His Course

3 MILES DOWN!

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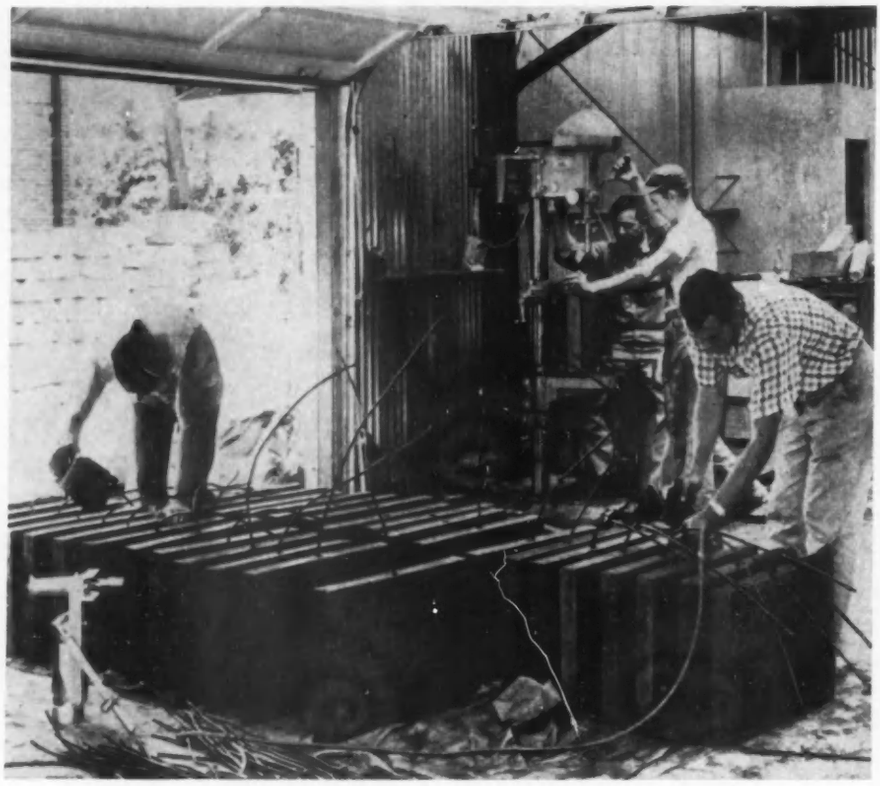

FIGURE 2—Special bolt on block type graphite anodes being prefabricated.

rent with somewhat better economics.

In the earlier periods of offshore activity most exploratory drilling was accomplished from a fixed platform, either self-contained or tender type. This was an expensive method of making location to drill a purely exploratory well which has only one chance in five of producing. More recently, it has been considered more economical by some offshore operators to accomplish at least the exploratory drilling with a mobile platform. These structures represent a considerably greater investment in the platform proper but greatly reduce the cost of establishing an exploratory drilling site. Some operators visualize using mobile platforms only for the exploratory operation and, once a field has been discovered, to continue the development of the field with the stationary platforms.

The construction of these mobile platforms generally falls into three categories; the fixed deck, the elevating deck, and the elevated deck types. Figure 1 shows the elements of construction of these three types. The fixed deck type uses the same general principles of construction as the bay barge; the lower section being composed mostly of ballast compartments which are flooded when the structure is placed on location. The other two types of construction use jacking mechanisms of one type or another that allow the deck section to be jacked up on upright columns or caissons to the proper position above mean Gulf level.

Obviously the problem of providing corrosion protection for the submerged surfaces of the mobile platforms is considerably more complex than in the case of the stationary platforms. Where the submersible hull is used it is necessary to provide for the protection of the internal surfaces of the ballast compartments. Cathodic protection to the external surfaces of the hull, the columns and piling must also be provided. In addition to the main barge section, pontoons are frequently attached to the barge. This presents additional external and internal surfaces for protection. In the case of the submersible hull type some of the barge compartments are used for portable water storage. These also must receive protection under circumstances of different circuit resistance. Some of the barge compartments may also be used for storage of industrial water for use in the drilling mud.

Usually an ample reserve of electrical power is available aboard these structures, and the cost of the incremental power which would be used from this reserve is considered quite low. The relatively cheap power has dictated giving maximum consideration to the use of the impressed current type of cathodic protection system. This type of system is also favored because of the more permanent nature of the mobile structure as compared to the fixed platform, especially when the latter is used for exploratory purposes. Accordingly, it is more feasible to design for longer anode life in the case of the mobile platform. Total current requirements for the protection of all of the submerged surfaces of an average mobile platform are considerably higher than that for the average stationary type; some 1000 amperes, average, against an average of 100 amperes or less. This is another point favoring the impressed current type system.

Prepolarization of the surface to be protected by the use of a high current density "shock treatment," followed by conventional cathodic protection, has proved to be the most economical approach to the initial protection of the stationary platforms. Several factors have made it more desirable and profitable to achieve polarization of the mobile platforms surface by other methods in most cases. These factors are: (1) a tremendous amount of temporary direct current, about 10,000 amperes on the average, would be necessary for the prepolarization of all surfaces of an average structure at the high current density, assuming no coatings; (2) some type of coating, though only temporary, is usually present to assist in prepolarization and (3) in most instances only a portion of the total surface is presented for polarization at one time. This allows all available current to be applied for a brief period to a portion of the surface.

The application of cathodic protection to an elevated deck submersible hull type platform, shown under construction in Figure 3, will be described as typical for this type of structure. Excess electrical power was available and, the cost of the incremental power generated over and above that needed for the normal operation of the platform was considered to be nil. Although preliminary cost estimates indicated the initial cost of the impressed current type of system was greater, the long range economics over a ten year period reflected the annual cost for the impressed current type of system to

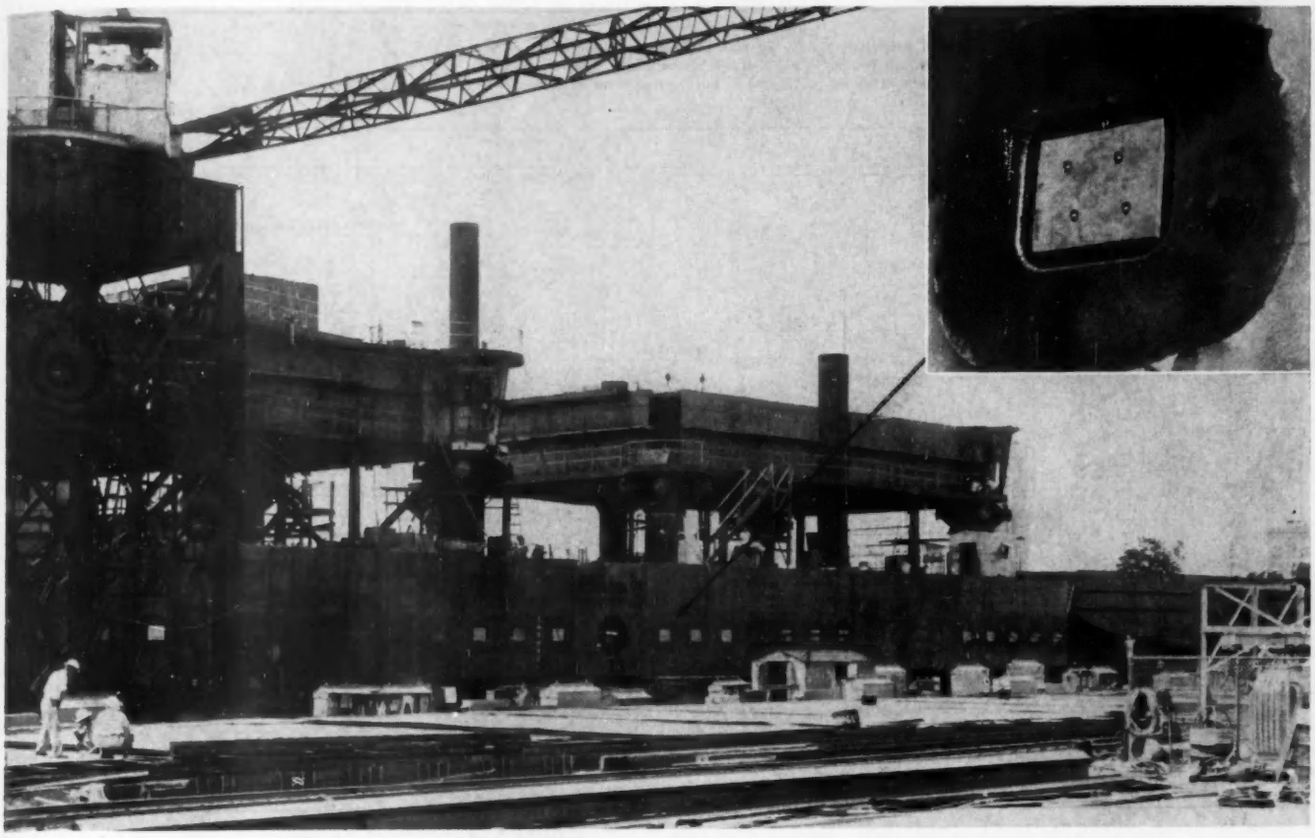

FIGURE 3—Elevated deck submersible hull type mobile platform under construction in the shipyard.

be approximately one-half of that for the galvanic anode type. Therefore, an impressed current type of system was selected for this structure.

Conventional graphite anodes do not lend themselves to direct attachment to the hull by an acceptable means. It is desirable to recess the anode into the hull for mechanical protection, so a new bolt-on, block type graphite anode was designed. The anode is approximately 17 inches x 24 inches x 2½ inches, and is linseed oil impregnated for salt water service. (See Figure 2) Figure 3 inset is a view of the anodes mounted in the recesses on the side of the hull. Neoprene coating was applied in the vicinity of the anode to assist in effecting more uniform distribution of current from the anode to remote surfaces.

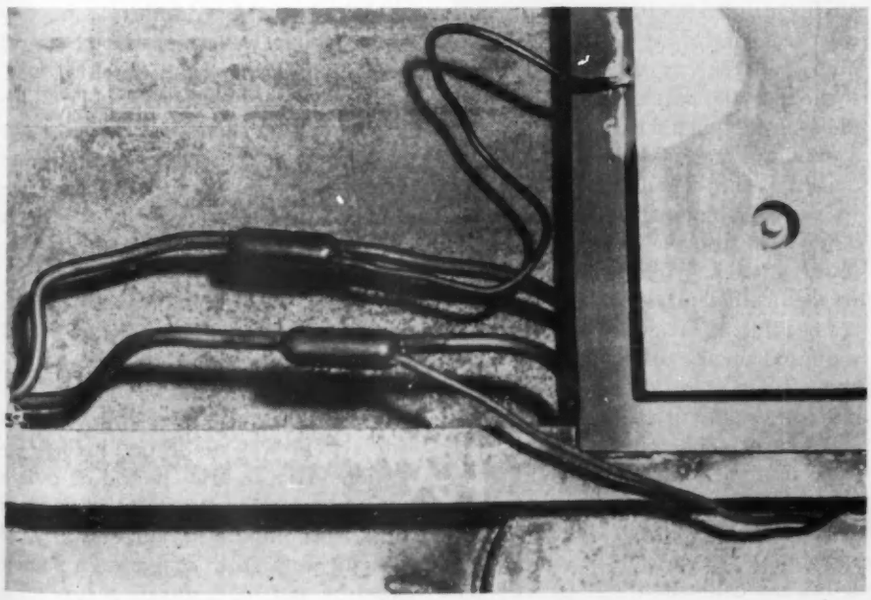

FIGURE 4—Section of internal block type graphite anode and lead wire splices to header cable.

For maximum protection of the external anode lead wires, they were brought through the hull adjacent to the anode and into the ballast compartment by means of double watertight fittings then connected to the header cable. Figure 4 shows a bolt-on graphite anode mounted for the protection of the internal surfaces, and the leads from the external anodes. Both leads are connected to their own header cable. The internal and external circuits were completely separate so that damage to one circuit would not materially affect the rest of the cathodic protection system. A plan view of the platform, showing locations of both external and internal anodes and their respective circuits, is shown in Figure 5.

Four void compartments that are open to the atmosphere through the large upright columns each contain one 200 ampere rectifiers for the salt water anode circuits and one 12 ampere midget rectifiers for the fresh water anode circuits. These rectifiers are, in effect, sitting on the ocean floor while the mobile platform is on location.

In this case, early consideration of

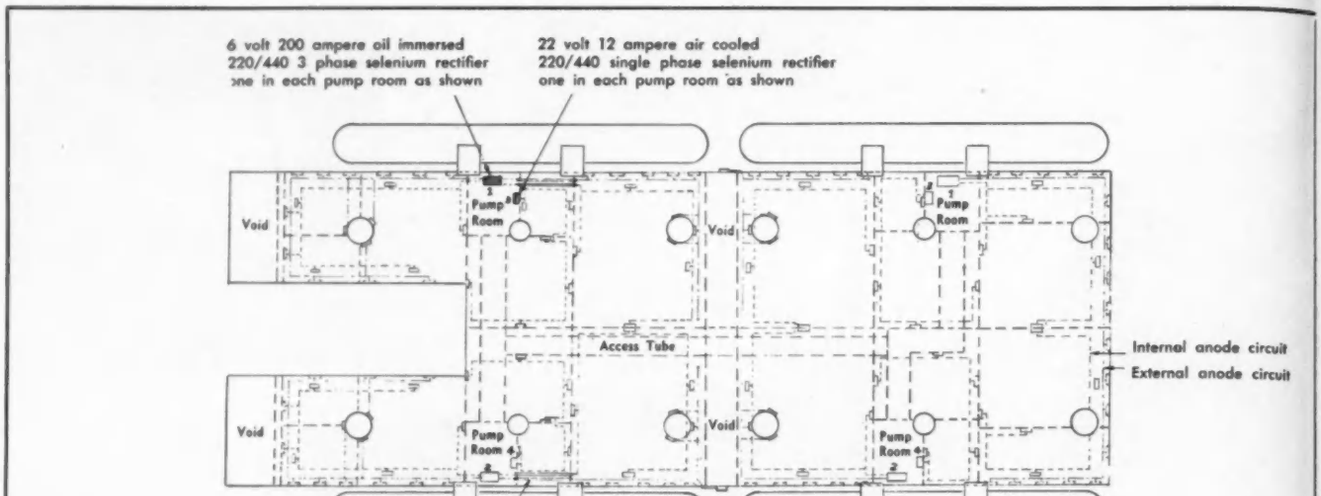

FIGURE 5—Locations of internal and external anodes and circuits.

the application of corrosion mitigation measures made it possible to design and install the cathodic protection system concurrently with the construction of the platform. Therefore, it was possible to energize the cathodic protection system immediately upon launching of the platform in the brackish harbor water, and accomplish polarization of much of the surface while the platform was being fitted out. Additional adjustment and apportionment of available current was made on the first location until the entire external and internal surfaces of the structure were polarized and complete protective potentials obtained over all surfaces. Subsequent inspection of the external and internal surfaces indicated the entire surfaces to be essentially 100 percent free from corrosion attack.

The cathodic protection of a submersible hull fixed deck platform designed to operate in 40 feet of water will be described to show the several modifications which it is possible to make in the impressed current type of system. Contract for protection of this platform was not awarded until after it had been launched for outfitting. Accordingly, it was not possible, or at least practical, to have recesses built into the hull. It was necessary to resort to the use of prefabricated bolt-on type graphite anodes mounted into a protective holder which could be welded direct to the hull just above water line while the structure was afloat. Here, instead of passing the anode leads directly through the hull at the point of attachment, they and the header cables were run through conduit on the outside of the hull and the vertical columns, as shown in Figure 6.

Due in part to the press of time it was decided to use a suspended type impressed current anode for the protection of the internal surface of the ballast compartment. The Duriron anode can carry quite high current densities on the anodes surface with no appreciable sacrifice in efficiency. There was also the possibility of using fewer anodes. Therefore these anodes were installed and the circuits were connected to one of the rectifiers mounted on the upper deck. Figure 7 shows a view of the meter panel of one of the rectifiers with shunts installed in each circuit for current measurements to the various compartments.

Since the pontoon sections were detachable, it was not feasible to run a header cable to them for the protection of their internal surfaces by an impressed current type of anode. Accordingly, 150 pound magnesium anode strings were suspended from the overhead for the protection of these internal surfaces. The external surfaces were automatically protected by the anodes attached to the exterior of the main hull, since the pontoon sections are securely "grounded" to the hull.

Because of the owner's preference for avoiding through-hull fittings into the fresh water compartments, they were not included for protection by the impressed current circuit. Magnesium anodes were selected for the protection of these surfaces. Because of the higher resistivity of the average water being stored in these compartments, and the need for a greater number of magnesium anodes to provide the necessary protective current, 24-pound, coated, strap type magnesium anodes, welded to the deck and bulkheads, were used as the best means of protection.

Here again, the final adjustment of the system was made on the first location. After a brief period of polarization those surfaces protected by both the impressed current type of system, and the magnesium anode type of system, protective potentials in excess of —0.78 volts, as referred to

a calomel electrode, were achieved. This potential is the generally accepted criterion for the achievement of complete corrosion mitigation of steel in sea water.

These case histories have been presented to demonstrate how some new approaches to the cathodic protection of steel surfaces in sea water can be employed to provide the most economical protection for mobile platforms. Protection of the platform utilizing the bolt-on type graphite anode with impressed current for the protection of all surfaces was achieved at an annual cost of about 3 cents per square foot per year, over a ten-year period. Annual costs of the combination type system described for the second type of structure was computed to be about 4 cents per square foot per year. Neither of these costs include any cost for power. The cost for a 100 percent galvanic anode type of installation for both of these structures was estimated to be in the range of 6 cents to 8 cents per square foot per year.

Undoubtedly some of the newer types of platforms of completely different design which are under construction, or on the drawing boards, will call for still different combinations of sources of cathodic protection current and different installation techniques in order to obtain the most economical cathodic protection system.

It is interesting to note that the application of cathodic protection to offshore drilling platforms, both stationary and mobile, has indirectly added impetus to the application of cathodic protection to other structures, such as the steel pilings of bulkheads and piers. The techniques employed are similar in many respects to those which have been used offshore. However, design data is not completely interchangeable. Due to industrial pollution, current requirements for the protection of steel in harbors where waters are very much less saline than sea water, have been found to be several times those for the protection of steel in open sea water.

ACKNOWLEDGMENT

This is a condensation of a paper presented by the authors at the NACE meeting in New York in March, 1956. The complete paper is being considered for publication in *Corrosion*.

REFERENCE

[1] *Corrosion*, Vol. 6, No. 7, 216-224 (1950) July.

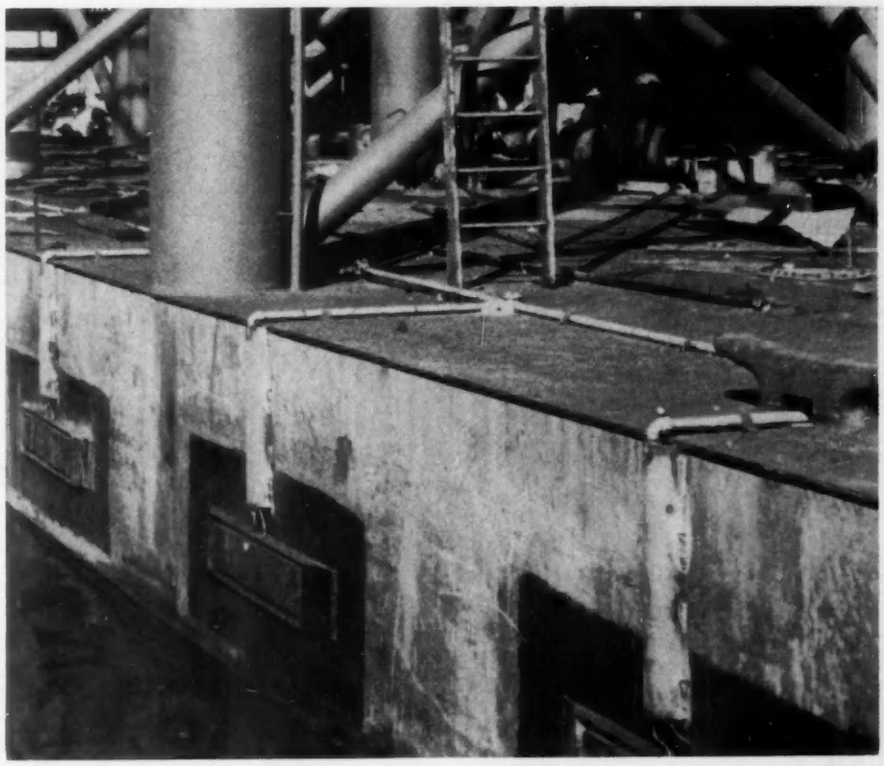

FIGURE 6—View showing anode leads and header cables.

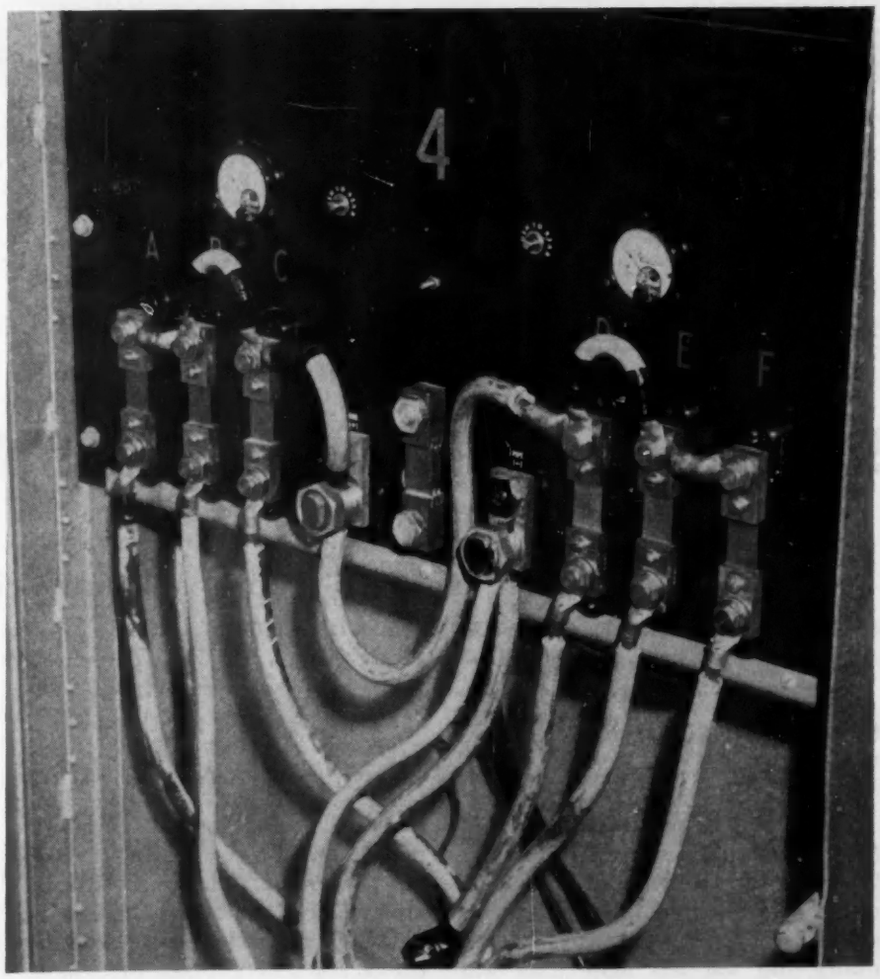

FIGURE 7—View of meter panel on large multi-circuit rectifier.

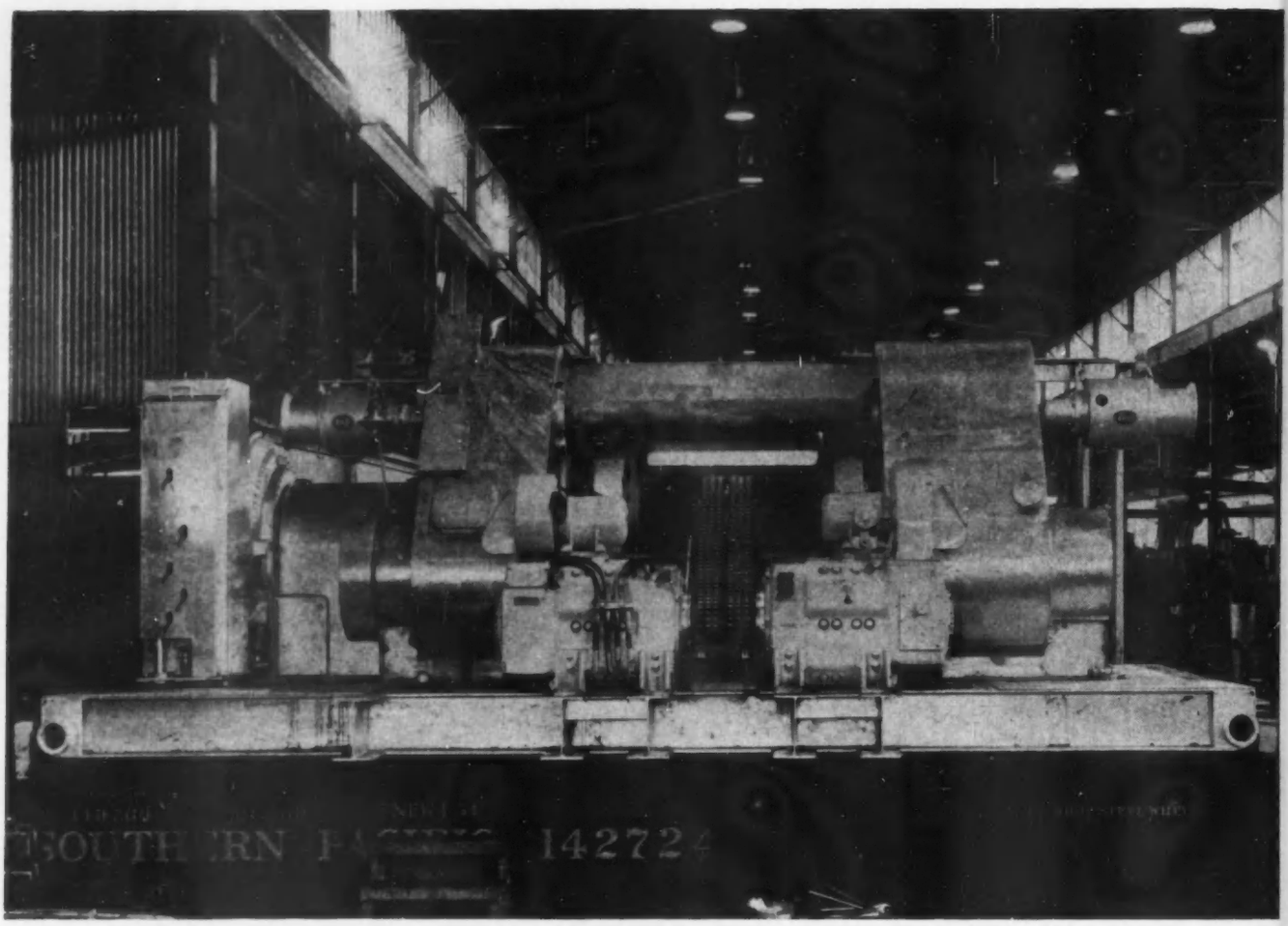

FIGURE 1—A large diesel electric drawworks that has been treated for corrosion resistance is prepared for shipment. This view of the drawworks gives an idea of the many component parts that must be treated if 100 percent protection is to be obtained in a corrosive environment.

Special Report on Corrosion

Painting Isn't Enough on Offshore Rigs

Operators are now zinc-coating all parts—even screws and bolts—in an attempt to reduce corrosion losses offshore.

By JOHN N. SCHUELKE
WORLD OIL Staff

CORROSION IN whatever form, and from whatever cause, is a continuing headache for maintenance men. Corrosion of drilling equipment is not as severe as in other segments of the industry and was not more than was normally anticipated for this type of service. The industry has always had to contend with corrosion of the blowout preventers and the substructures around the wellhead and in the mud tanks where various mud additives, chemicals, caustics, etc. were in use. Frequent scraping and painting seemed to hold this corrosion to a minimum and it was never considered to be too great a problem.

However, with the advent of offshore drilling, where structures are erected or submerged many miles offshore; all equipment, not just the

structures, is at the mercy of severe weather conditions of high humidity, salt air, and sea water not to mention the regular corrosive elements of drilling mud and chemical additives that are found on land rigs. In this environment, painting alone, as we understand the term, is not enough.

In other articles of this special report the science of painting a drilling rig and substructure has been covered rather thoroughly. Different methods of protecting drilling structures offshore have also been mentioned. But, what about the drilling equipment and auxiliary equipment that is on the offshore rig floor above normal wave or splash action? Damage to this equipment is due to the salt air and spray. Corrosion can attack any metal where even a minute opening allows the salt air to filter through.

It is not sufficient to consider such composite items as drawworks, rotary table, hook, swivel, pumps, etc. Each separate part of these main pieces of equipment, as; bearing housings, retainers, shafts, spacers, flanges, sprockets, keys, universal joints; in fact all metallic objects that are not immersed in an oil bath, must be considered and protected.

There are a number of different processes and procedures that have been developed and applied over the past ten years to make drilling rigs as non-corrosive as possible. It will suffice to say that no one process such as galvanizing, painting, coating, spraying or cathodic protection is sufficient to protect each and every part of a drilling rig. Most corrosion resistant treatments employ a combination of these processes depending on the size, use and operational environment of the individual pieces.

One of the most common methods of corrosion protection is zinc coating. Zinc coating protects iron or steel by sealing the metal off from the atmosphere. When flaws appear in the zinc covering due to age or if there are any discontinuities of the coating due to mishandling then galvanic action ensues and the steel is protected by sacrificial action. Zinc acts as the anode and the steel as the cathode. If properly applied galvanizing should give corrosion protection for 15 to 20 years, depending on atmospheric conditions.

Zinc may be applied to iron and steel by three general methods: hot dipping, low temperature coating, and electrolytic deposition. The hot dip method is used for the majority of applications and is usually applied by the hand-dip process. The temperature of the zinc in the tanks is 850° F. which is not high enough to cause volatilization.

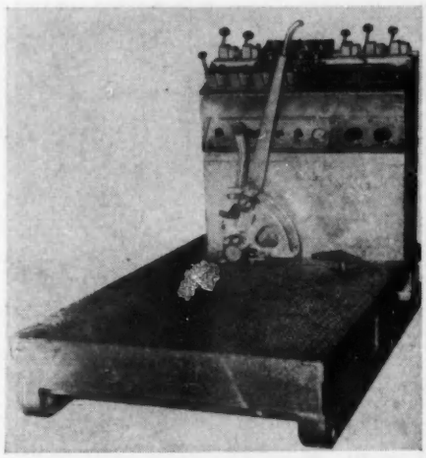

FIGURE 2—Driller's console is also treated to resist corrosion. The skid and console housing have been hot dip galvanized.

In the past, drilling derricks, masts, and production tanks have been galvanized. In the last few years drawworks, rotary machines and other major items of drilling equipment have been zinc coated in an effort to combat the corrosive environment of offshore operations.

Because of the size of the drilling equipment and the available sizes of the galvanizing dip tanks it is necessary to hot dip the larger pieces of equipment in sections or as separate parts. On one large rig delivered to a major oil company the drawworks, console and rotary were all galvanized. These are the steps necessary to protect the drawworks. The drawworks skid was galvanized, then the pedestal post and lower chain guards were galvanized and then welded to the drawworks and a zinc coating was applied over the weld area. The bearing boxes were welded to the pedestal post with the bearing assembly in place and zinc coating was applied over the welds. The upper drawworks guards were galvanized separately and fitted to the bottom guards at the time of assembly. The selective transmission skid was galvanized as one piece. The selective transmission itself was galvanized in separate pieces, welded together and zinc coating applied over the weld. Other and miscellaneous items that were galvanized included; brake pedestal, rotary counter shaft frame, bearing retainers, hose clamps, brackets, water tank, brake bands, brake rims, rope roller assembly, and miscellaneous bolts and cap screws.

After the larger sections had been welded together, a zinc bar containing flux was used to restore the continuity of the zinc coating. This is the low temperature coating application. This assures 100 percent protection of the weld area. The zinc coating also helps to smooth the weld as it flows into the pin holes and crevices when applied. On offshore structures and equipment it is used to protect the weld area against salt water corrosion.

The surface to be coated with the zinc was pre-heated with a welding torch to about 600° F. A bar of zinc was rubbed against the heated surface, allowing a small amount of zinc to flow. This was then wire brushed briskly thus spreading the material evenly over the area to be covered, and was brushed sufficiently so that a bright finish was secured. If a heavy deposit or build-up is desired after the initial bond has been obtained, more zinc is applied and agitated with a paddle or brush until the required thickness is obtained. The most important thing to remember in applying zinc in this manner is to get the surface plenty hot. The zinc alloy can not be burned off even if the base is heated to a cherry red. Sufficient heat insures a bright smooth finish without any rough particles.

Items that had finished machined surfaces such as; bearing housing, retainers, shafts, spacers, flanges, and sprockets were painted or sprayed with a zinc base coating (Dimetcote) and then the coating was cured.

This is a completely inorganic zinc coating that has been developed for protecting metal surfaces. It need be applied in only one coat to provide an excellent protection under most conditions. The coating must be applied free from pin holes and holidays over a properly prepared surface. The minimum dry film thickness must be .0025 inches (2½ mils). One coat applied at the recommended rate of coverage will normally provide this thickness.

All metal surfaces must be dry sand

FIGURE 3—Rotary machine was hot dip galvanized and is fully corrosion resistant.

blasted to provide a surface free of all mill scale, rust, rust scale, grease, paint or foreign matter. When blasting is completed the surface of the steel must be an even gray-white color. Blotchy surfaces indicate incomplete blasting and are not satisfactory. Since blasted surfaces rust rapidly, the zinc coating must be applied as quickly as possible after blasting. The bare metal surfaces can not be left overnight without coating. Grease, oil or other organic matter should not come in contact with the surface prior to application.

This zinc coating is composed of two materials; a reactive liquid and a finely divided powder, which are mixed together before application. It requires no primer and one coat provides maximum corrosion protection. The unmixed solutions have an unlimited life. Coverage depends upon the roughness of the metal surface. For a smooth surface, the coverage is 300 square feet per gallon of the mixed coaitng.

The zinc coating can be cured chemically with a curing solution or by baking at 350° F. for one hour. Once cured by either method, it is completely insoluble and will provide a very hard, abrasion resistant metallic surface. Little maintenance is required to obtain many years protection against severe weather conditions. Any break which might be caused by accident or unusual abuse, unless extremely large, will be cathodically protected by the coating remaining on adjacent areas. These breaks, however, may be easily repaired by brushing another coat over the damaged area.

The completely cured coating is hard and tightly adherent, and will follow the normal expansion and contraction of rigid steel surfaces without difficulty. The coating is not designed to be used where metal is to be drawn, twisted or bent sharply. A reaction between the coating and the steel helps bind the two together so that it is nearly impossible to separate the coating when properly cured.

The coating is completely noninflammable in either its liquid form or when completely cured. It will not support combustion and creates no danger of fire during its application. However, if the chemical curing is employed, suitable precaution should be exercised during the application of the curing solution which is an inflammable liquid.

When immersed or continuously exposed to water, the maximum temperature limit is 120° F. When not immersed, it will withstand continuous exposure to temperatures as high as 500° F. and it will resist brief exposure to temperature as high as 700° F.

The actual service and weather conditions varying from extremely high humidity to very dry, hot climates has produced no visible change in the coating. This coating has complete resistance to salt water and continuous exposure over several years period has not shown any visible change in the film. However, it is not recommended for acidic exposure nor for alkaline solutions.

Items which would be exposed to climate conditions in service were immersed in a compound for rust resistant use on iron and steel. This compound (Parco) can be used on any particle or part regardless of size or shape. Variations from the original dimensions are very small so that manufacturing tolerances are maintained. Small pieces may be treated in baskets or tumbling barrels, larger pieces may be suspended on racks. This coating compound is composed of millions of microscopically fine crystals. It is non-metallic and thus forms a barrier against the corrosive actions of moisture in the elements. In order to apply this compound, the work must be free from all oil, grease, scale and foreign matter before the item can be successfully treated. Metal parts which have been completely machined may need no preliminary cleaning operation. This may also be true of some of the stamped and pressed steel parts. Rough castings and other articles having a heavy scale or coated with oil or grease require careful cleaning to prepare the surface.

Most of the exposed parts of the brake assembly and brake band support, as well as a number of pieces of the clutch assembly, hydraulic brake controls and worm drive assembly were coated in this manner. Keys, universal joints, brake and lever pins and clutch springs were also treated.

On items which were not exposed but are lubricated with oil spray no non-corrosive methods were used.

In extremely corrosive environments, as offshore, paint is also applied to the galvanized surfaces.

These processes and procedures are continually undergoing change as experimental work continues in order to provide the best possible corrosion resistant coating for offshore equipment. As these products and procedures improve, it is hoped that the tremendous annual loss due to corrosion will be decreased. It will require not only considerable testing, but a great amount of patience and time to collect and analyze the data of many different applications and tests over a long period of time. —**The End**

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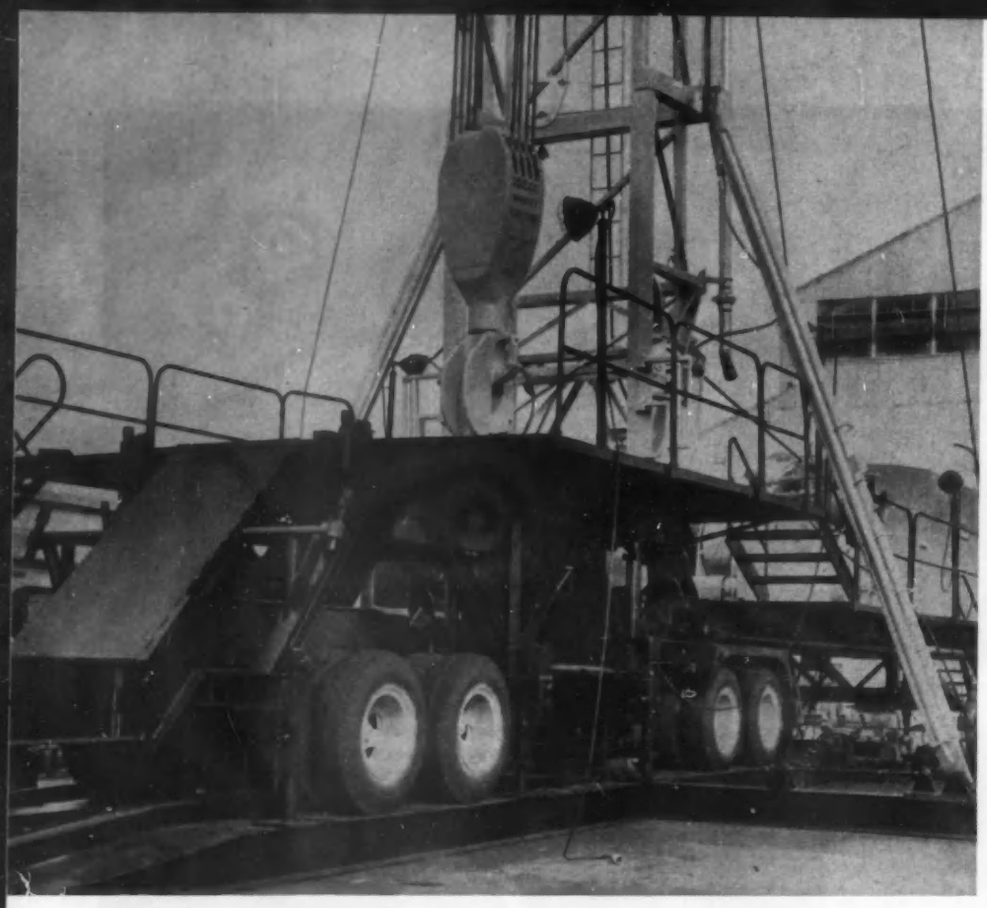

FIGURE 1—The mast trailer and the drawworks trailer buckled together on the ramps while the rig is being assembled in the manufacturer's yard. Note the space between the wheels showing how the two trailers are connected with turn-buckle spacer beams. The raising legs are in stabilizing position on the grillage beam. Drilling line reel is in place under the pipe slide.

Diesel Electric Rigs Are Going Portable

A trailer-mounted rig rated at 7000 feet with 4½-inch drill pipe is equipped with diesel electric power to combine power and portability in three main trailer loads.

A RIG THAT incorporates two features that are bywords in the drilling industry today—power and portability—was delivered recently to a major oil company for operations in the Rocky Mountain area. This diesel-electric rig of variable engine-speed design uses one generator per engine. Highly portable, it can be moved in three main trailer loads with pumps and miscellaneous equipment requiring approximately two to three more loads. This does not include the mud tanks or the drill pipe. Figure 1, shows how the drawworks trailer and the substructure and mast trailer fit together to form a complete drilling unit.

In this novel adaptation of diesel-electric power to a portable rig, four direct current generators driven by four diesel engines and two alternating current generators driven by two smaller diesel engines are mounted in a trailer along with the AC and DC control panels. This unique rig combines the highly portable and flexible features of both the trailer mounted rig and the diesel-electric drive into one compact package. Rig-up and tear-down time will be greatly reduced and considerable flexibility will be added to the drilling operations themselves.

The drawworks trailer, measuring approximately 41-feet 9-inches long by a roadable width of 10-feet, weighs approximately 37,000 pounds at the bogie and 17,200 pounds at the king pin. The weight on the drawworks trailer includes the hoist, the electric motor, walkways, dog house and the rotary propeller shaft.

The drawworks is of standard manufacture and is rated at 7000 feet with 4½-inch drill pipe. It has two forward and one reverse or three forward speeds and is equipped with a 22-inch high speed hydromatic brake. The drawworks is driven by a 625 hp DC electric motor mounted behind the drawworks. (See Figure 2.)

The rotary table is driven by the same motor through a special spiral-bevel, right angle, gear box that is mounted in front of the drawworks. (See Figure 3.)

The mast trailer can be broken down, if necessary, so that the substructure and the mast can be handled in separate loads, or where permissible, it can be roaded in one load. When roaded in one load, the mast substructure trailer will measure approximately 49-feet in length and is approximately 8-feet wide. This trailer with rotary and substructure weighs 47,000 pounds at the bogie. With the rotary removed it would weigh 41,230 pounds. The weight at the king-pin of this trailer is 17,290 pounds without the rotary and 18,460 pounds with the rotary. The mast trailer carries the substructure, pipe slide, catwalk (see Figures 4 and 5), head rest, spooling drum, 2000 feet of 1⅛ inch wire line, rotary cradle, complete mast, raising legs, jacks, 160-ton traveling block, raising and telescoping lines, 17½-inch rotary,

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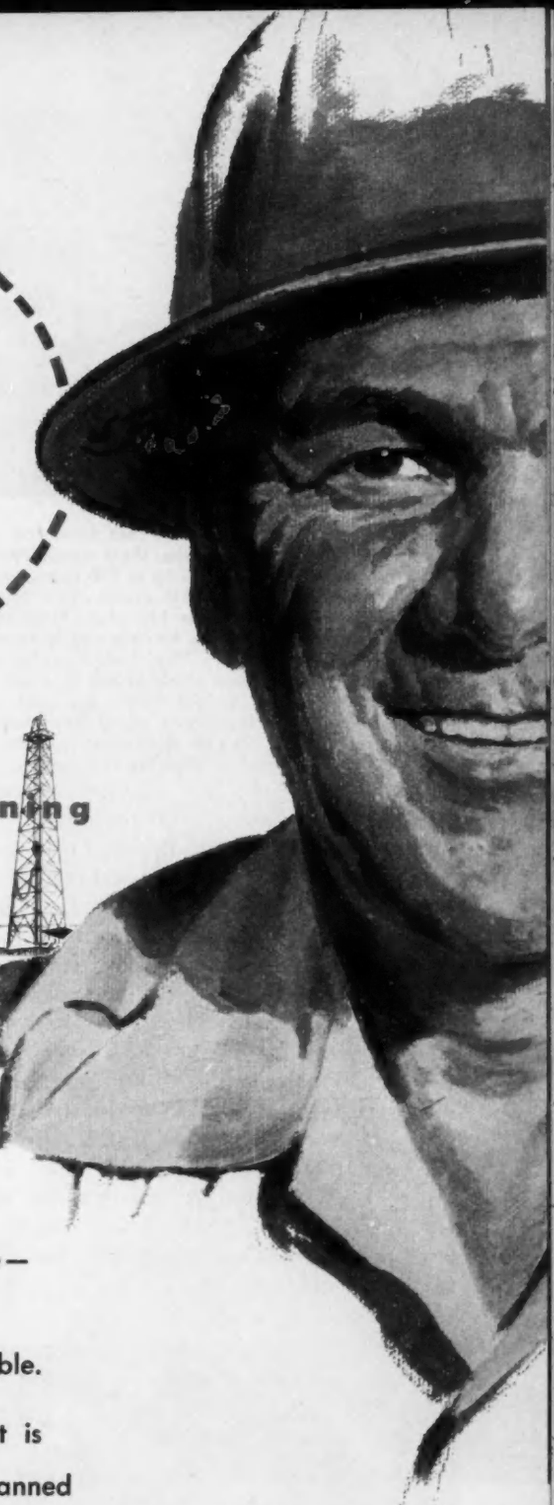

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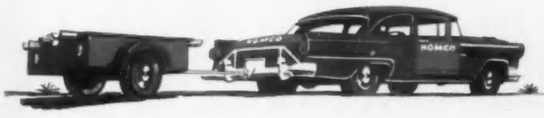

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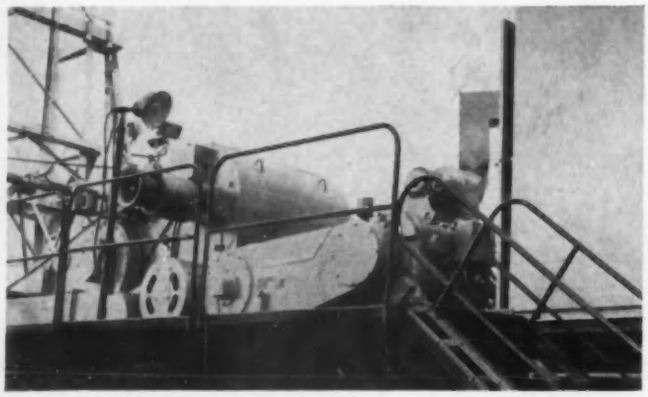


FIGURE 2—The DC electric motor that drives the drawworks and also the rotary table is a traction type, shunt wound motor rated at 625 hp at 950 rpm continuously or 1000 hp at 950 rpm intermittently. Bolted to the trailer bed directly behind the drawworks it transmits power to the drawworks by a 1¼-inch triple link chain. This motor has a sealed, grease lubricated, anti-friction bearing and is ventilated by a blower mounted on top of the motor. The blower is rated at 1500 cfm and is driven by a two hp explosion proof squirrel cage induction motor of 440 volt 60 cycle power. To insure complete explosion proofing there is an air duct leading from the blower motor down beside the dog house. The drawworks motor weighs approximately 6900 pounds. A similar motor drives the mud pump.

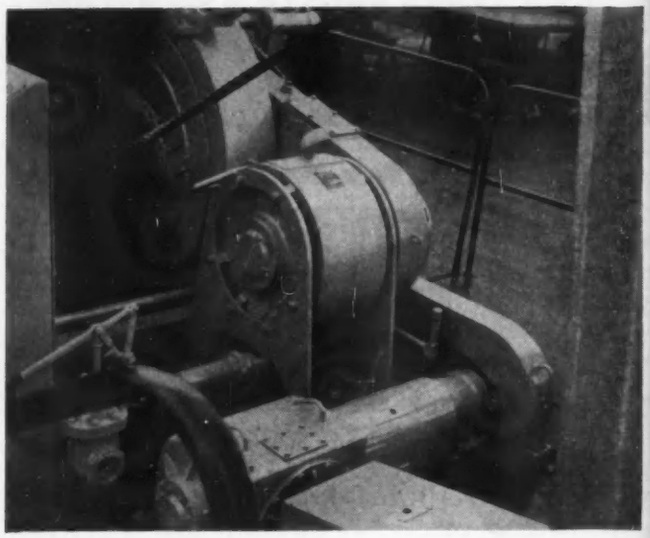


FIGURE 3—Front view of the drawworks showing the 18-inch diameter main drum, the 22-inch high speed hydromatic brake and the right angle rotary drive.

lights, 4-inch standpipe, and the tong counter weights. Wide walkways provide unobstructed work areas and can be removed or folded to the dimensions given above. The mast requires no external guys and only one pair of internal guys to the goose neck of the drawworks trailed.

The blowout preventer and swivel can also be carried on the mast trailer.

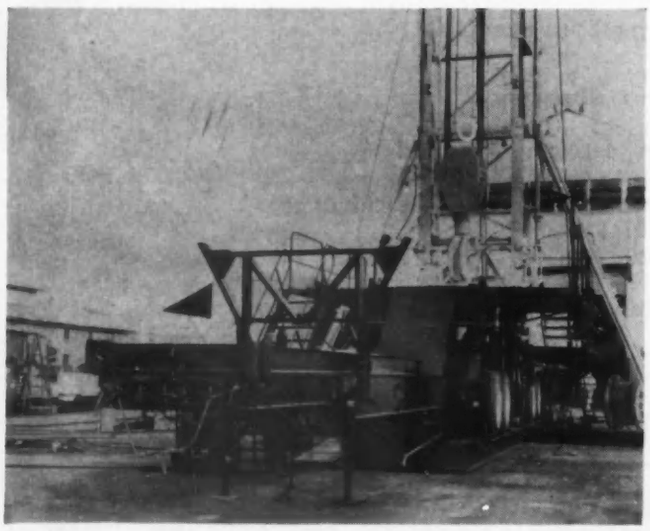
The substructure, that can be transported with the mast trailer, is approximately 8-feet 1-inch wide and has a clearance of approximately 9 feet. This allows ample room for work on the blowout preventers, or for well completions.

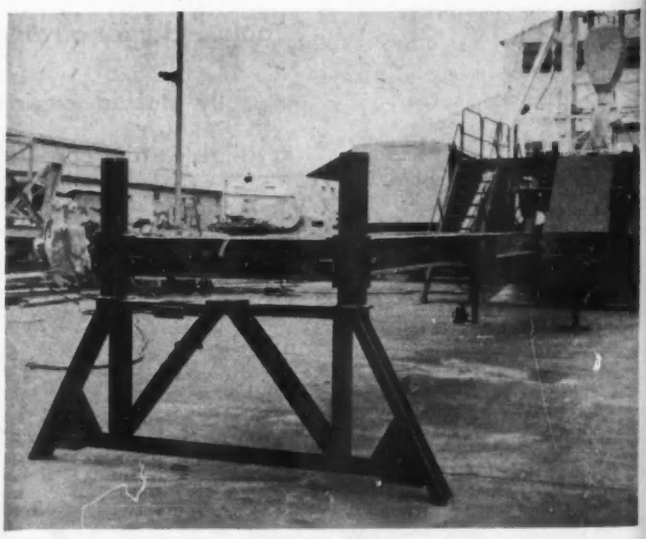
Drive-over ramps can be used under the trailers to aid in positioning and also to distribute the load over the ground and eliminate the use of matting boards. The two ramps, one for the mast trailer and one for the drawworks trailer, form a complete bridge around the well site. This permits one trailer to be driven in forward over the well center for quick spotting on its own ramp. Thus only one trailer has to be backed into location. No expensive preparation of location is required.

Heavy turnbuckle spacer beams with sledge pin connectors form a rigid truss between the vehicles. Screw jacks transfer the entire load to the ground relieving the weight on the wheels.

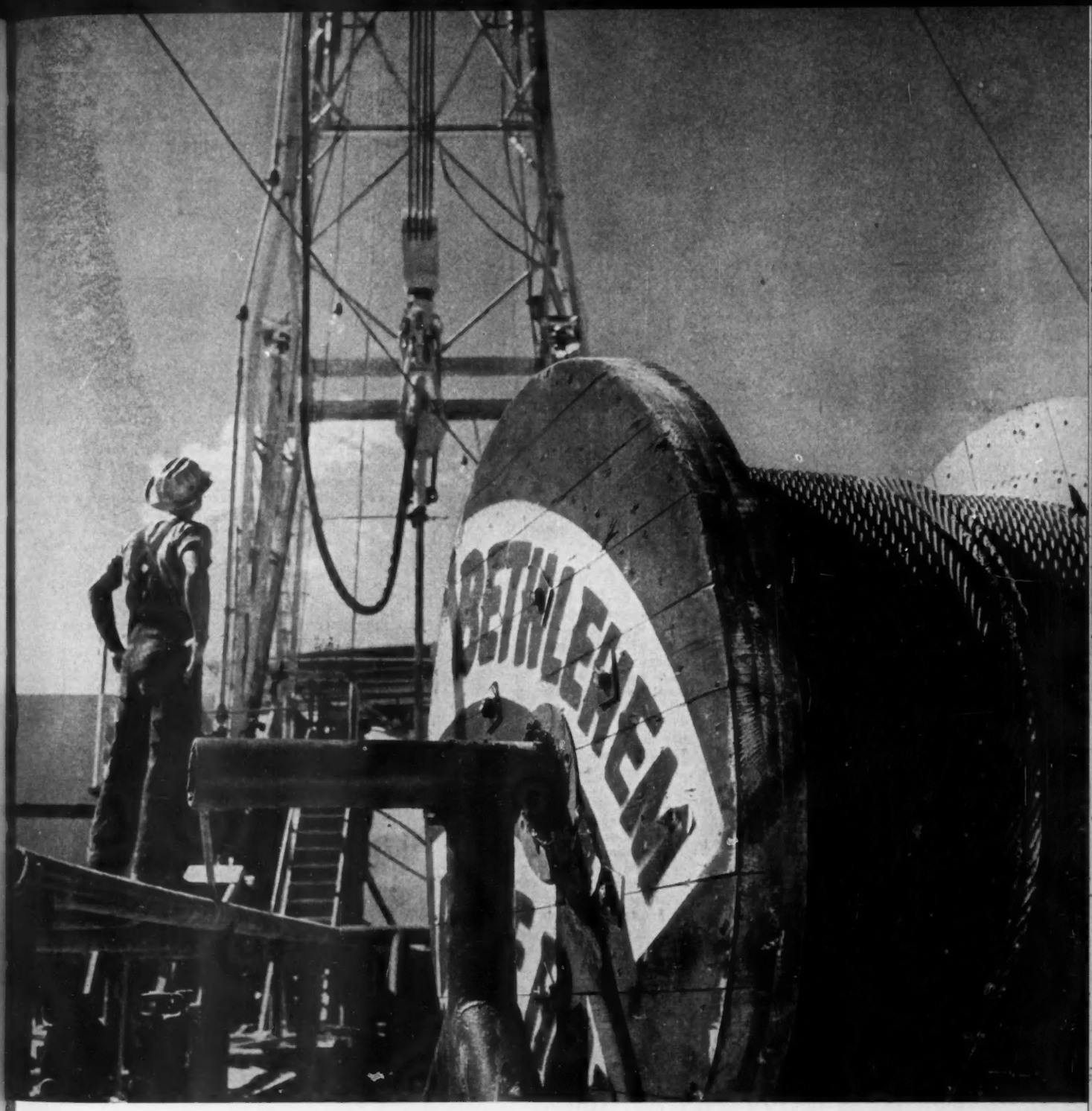
The mast is raised to vertical by hooking the traveling block to raising leg bridle. The raising legs then become side stabilizers by pivoting them 90 degrees to the side with the cat line and attaching them to the grillage beams. (Note Figure 1.) The 105 foot mast is then extended to full height with the traveling block and has a net hook capacity of 268,000 pounds with eight lines strung.

The third trailer houses the power and generating equipment. In figures 6 and 7 the four engines driving the





FIGURES 4 and 5—The pipe slide and walkway are made integral with the mast trailer. The head rest, or carrying cradle for the mast, is removed upon erection of the mast, turned over, and forms the support for the end of the walkway. In Figure 4 the walkway and head rest are in road position. Note the trailer hitch and air hose connections at the front of the trailer. In Figure 5 the head rest is removed and inserted in the brackets at the end of the walkway, the top part of the walk is pulled out until it falls into position, thus extending the walk to full length.



Wire Rope at Work—Far out on the rolling West Texas prairie, the contractor was putting down a wildcat well when this photograph was taken. Drilling at that time was in the Ellenburger formation; it had already passed 7200 ft, and the plans called for going another 300.

The rig was equipped with a jackknife mast and approximately 3500 ft of 1⅛-in. 6x19 rotary line. This stout wire rope was Purple Strand Form-Set, Bethlehem's top-grade preformed. Like all Bethlehem rotary lines, it handled the heavy strings of drill pipe with no fuss or strain, meeting every demand of the job with plenty to spare.

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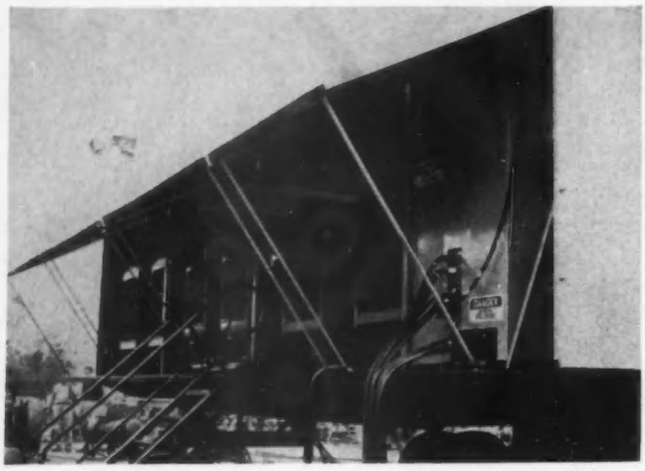
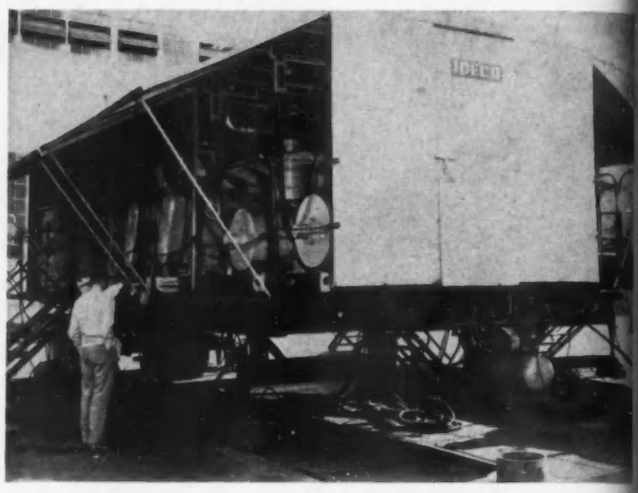




FIGURES 6 and 7—Power to operate the rig is supplied by four six-cylinder, four-cycle, valve-in-head, diesel engines that weigh approximately 4100 pounds each. A flange mounted single bearing traction type generator that can absorb an engine output of 320 hp at 1800 rpm continuously is attached to each engine. These are three-field generators that are self-ventilated. This power trailer also includes two 119 hp rated, six-cylinder engines (in the center) that drive two 30 kw AC generators that are three-phase 60 cycle, and two 25 kw compound wound DC exciters for the separate excitation of the DC generators. This power trailer measures approximately 36 feet 9 inches in length by 10 feet in width when roading and 13 feet 3 inches wide when the walkways are down.

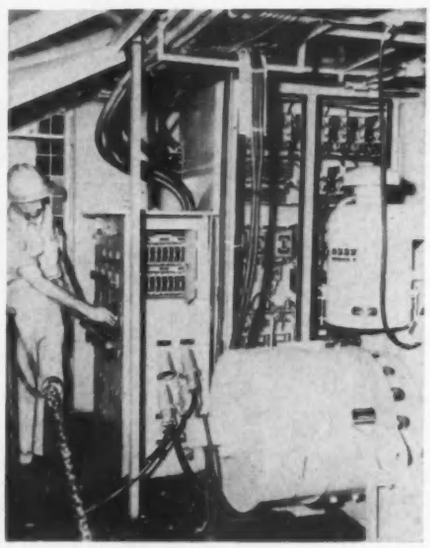
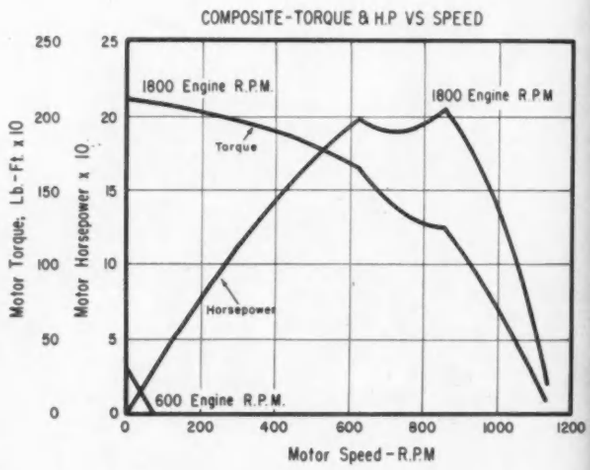


FIGURE 8—The large DC main control panel (left) is shown at the rear of the power trailer, while a workman makes adjustments on the smaller AC control panel. Note the compact manner in which the wiring is grouped near the trailer roof.

FIGURE 9 (Right)—Operating curves of torque and horsepower vs. motor speed for one engine driven generator assigned to one motor. Values are approximate based on calculations.



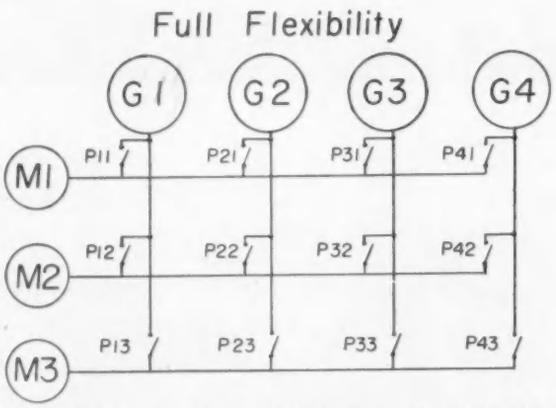


FIGURE 10—This diagram indicates how full flexibility is obtained. Any generator, or all generators can be connected to any one motor—up to the motors input rating.

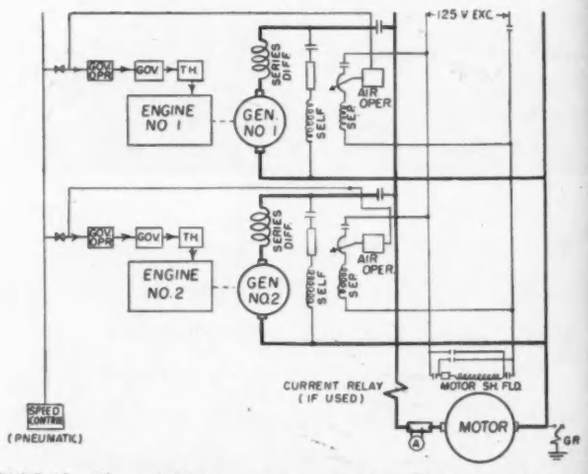


FIGURE 11—Three field generator construction. The separately excited field receives its excitation from a separate 125 volt DC source, and is varied over the speed range to give the "soft start" features necessary for fishing, catheading, etc. The self-excited field obtains its power from the output of the generator. Such an arrangement provides a degree of automatic control of the engine which in turn reduces engine lugging. The series differential field is included to limit the maximum output current thus providing a limit of stall torque developed by connected motors.

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four DC generators and the two smaller engines driving AC generators can be seen. The AC and DC main control panels are also located in this trailer. (Figure 8.) The trailer has a road width of 10 feet. The lower 19½ inches of the trailer sides fold down to form walkways while the upper parts are raised and held in position by poles.

This trailer can be driven onto location and spotted in almost any convenient place within 75 feet of the drawworks trailer. There is no alignment problem. It is only necessary to unreel the electrical cables and plug into the pump and the drawworks motors. AC electrical cables can be strung in the usual manner for lighting and running auxiliary equipment.

The electrical equipment takes the place of torque converters and compounds, and transmits smooth controlled power to the drive equipment for maximum operating flexibility with minimum maintenance.

With only one DC generator connected to a motor, a large number of operating curves are available all the way from the idle to full engine speed, Figure 9. Each intermediate curve depends on the position of the speed control lever. When two or more generators are connected a different family of curves at higher values of torque are available. Generators can be paralleled to a motor in the desired combination up to a motor's rating; and dependent upon the size of the engine up to four generators can be connected to any one motor.

Figure 10 indicates the flexibility to be furnished on rigs using the engine-generator combination as noted above. All engine-generators can be assigned to any motor. This is called "full flexibility."

The combination of a shunt motor with a three field generator (differential compound) provides a limit on the electric power speed depending on the position of the speed controller. (See Figure 11.) Even if load was suddenly lost, the motor would only speed up to the no-load speed point corresponding to the engine-generator output curve the operator is working on. The features of both limited stalled torque and limited no-load speeds are inherent in the motor and generator design. They do not rely upon the proper operation of complicated external control devices. This permits maximum simplification of control equipment requiring only simple contactors, relays, resistors, and solenoid valves.

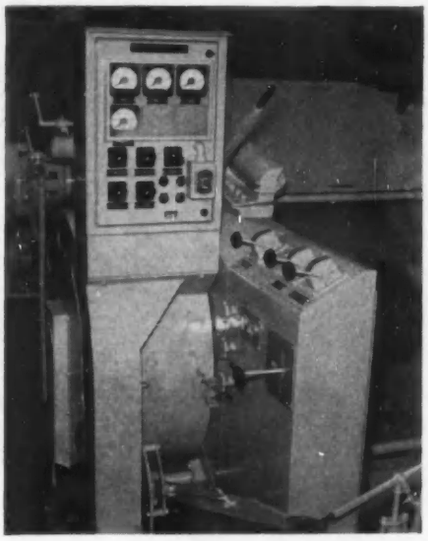


FIGURE 12—The driller's station with the additional controls for a diesel electric rig. The driller can select the generators to drive the drawworks or pump motors and the speed control circuits for the corresponding engines are automatically connected to the drawworks speed controller. Manipulation of the drawworks speed controller will adjust the governor settings of all engines whose generators are assigned to the drawworks motors at that time.

The variable engine-speed system provides for a smooth transition for the drilling crews from mechanical to electrical drilling. The speed control of the drilling equipment motors is obtained by remotely controlling the speeds of the engines in a manner identical to that normally used on mechanical rigs. The mechanical rig air system has been incorporated with the electrical equipment to provide for as much similarity at the drillers controls (Figure 12) as possible. This arrangement of apparatus will give the driller excellent flexibility of power, smooth operation and a simple system to maintain.

Thus, diesel-electric equipment can supply flexibility of power and reliability of operation with a high degree of portability.

Since electric equipment includes few wearing parts; only contact tips and brushes, maintenance expense is reduced to a minimum. Bearings are anti-friction, grease lubricated and sealed. Relubrication is required not more than every three years.

Electric transmission permits location of the power units away from the well thus reducing the fire hazards and also removing the noise and vibration from the drilling platform. In emergency, all power can be shut down by pressing only one button.

In normal operation, the initial torque applied when accelerating the load is very low. This small applied torque takes up slack in the drive chain or belt and if sufficient may bring the load up to a very low speed. As the speed control handle is advanced, an infinite number of gradually higher speed torque curves are obtained which increases the applied torque and the speed of the load, under the drillers control. This eliminates shock load on mechanical components and means longer life and reduced maintenance.

In addition to the features described above, electric equipment lends itself readily to modifications or additions to achieve different operating characteristics. Complete and accurate instrumentation of tests is easily accomplished. Electrical charts of torque, speed or power can be obtained for analysis in any combination desired. It is felt that these features may be extremely valuable for pioneering on an experimental rig.

In the past, diesel-electric rigs have not been too attractive to the drilling industry because of the high initial cost of the various electrical components. However, with the adaptation of traction type equipment that is mass produced by the electrical manufacturers, the cost has come more in line with regular mechanical equipment. Originally this traction type equipment and the generation of the power came only in the larger packages that made this type of rig attractive only for offshore operations where the weight and cost were not the big factors. However, with the application of smaller engines for power generation, and trailer mounting, the whole diesel-electric power unit will have an opportunity to prove itself on small, highly portable rigs. Maintenance and transportation costs should be greatly reduced but a tremendous savings should be affected in rig-up time alone because of the elimination of alignment problems in compounds, mud pumps, etc.

—The End

FIGURE 1—Pump rod disjuncture (break) due to sulfide corrosion.

FIGURE 2—Example of external tubing due to sulfide corrosion.

Special Report on Corrosion

What Causes Corrosion in Pumping Wells?

Here is an explanation of the electrolytic, galvanic and chemical action that may be eating up your profits.

By PAUL MENAUL
Ocie, Mo.

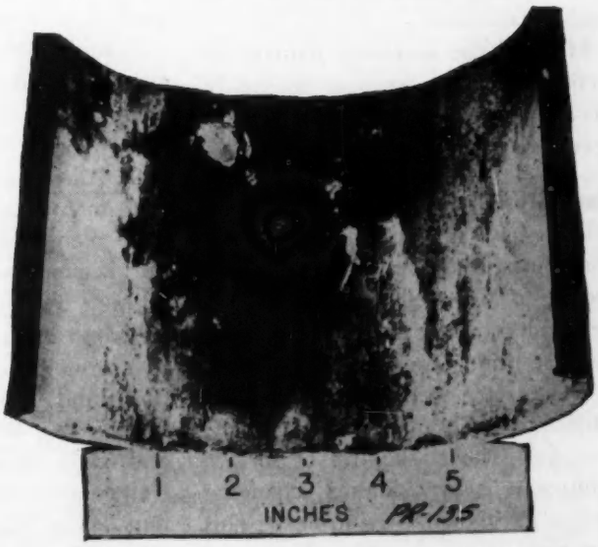


FIGURE 3—Example of casing corrosion in the Hobbs field, New Mexico, due to hydrogen sulfide.

See Section on Chemical Corrosion, Page 159.

CORROSION OF a metal instrument is its change to a chemically combined state. Its useful metallic properties are then lost. It is no longer a useful instrument. This phenomenon costs the petroleum industry a fortune each year in surface and subsurface equipment. The cost in dollars and cents alone warrants a better understanding of

Will cathodic protection work on a pumping well?

this reaction and measures which may be taken to halt or at least reduce it.

Corrosion of oil field equipment is electrochemical and chemical. Corrosion of a metal produces a DC electric current, conversely, an electric current can cause corrosion. The common example is the dry cell battery. This instrument is a base metal, zinc, separated from carbon or noble metal, both in contact with an electrolyte or salt solution. As long as the zinc and carbon elements are separated, or have no external metallic connection, the isolated zinc metal corrodes until it builds up a certain negative potential, then corrosion stops or proceeds at a very slow rate. But if the zinc is metallically connected to the carbon to which the electric current can flow then corrosion of the zinc proceeds. Another example: a panel of lead immersed in hydrochloric acid shows no corrosion even after weeks of immersion, but if the lead panel is connected to an iron panel also immersed in the same hydrochloric acid solution, corrosion of the lead panel is soon noted, and an electric current is generated between the lead and iron panels.

To corrode, the metal does not need to pass into solution in an electrolyte, it needs only to combine with another element. Iron combines with oxygen forming iron oxide and a negative electrical potential is produced on the metal.

These reactions affect metallic oil field installations.

Most of the corrosion damage affecting pumping wells is caused by electrolytic, galvanic, and chemical agents such as hydrogen sulfide.

Electrolytic Corrosion. In the oil field we have steel surface tanks, gathering lines, and long flow lines connected to the well equipment. The well penetrates far into the earth and contacts brine waters or electrolytes.

The surface steel installations are subject to corrosion, producing a DC potential. The corrosion of surface equipment is by oxidation, changing iron to ferric oxide—Fe to Fe^{+++}. This corrosion generates .75 volt greater than the subsurface oxygen free corrosion which is a change of the iron to ferrous chloride—Fe to Fe^{++}. This higher potential generated by the surface corrosion causes current to flow down the well equipment resulting in subsurface electrolytic corrosion. Electrolysis is the opposite of electroplating. It is the removal of metal by an electric current.

Wells in the World Pool of West Texas developed casing perforations opposite a water sand at the 2000-foot level. The flow line to a large storage tank was the only metallic connection to a well. The flow line was parted at the well head and a meter connecting the parted ends showed 1 ampere flowing into the well. This electric current was generated by corrosion of the storage tank. The tank can be compared to the zinc of a dry cell battery, the current flows to the well through the metal pipe line, down the well; the return circuit is through the moist earth.

When this current leaves the casing, each electron must be carried by a metal atom. This is electrolytic corrosion. One ampere of DC current will remove 25 pounds of steel per year. This corrosion is not distributed evenly over the entire casing. It is localized in small surface areas or hot spots so perforation may occur in a few years. Flow line currents of 6 amperes have been measured. Wells in the Goldsmith field of West Texas known to have perforated casings showed higher flow line currents of .5 to .6 ampere while those not yet perforated showed .2 to .3 ampere.

A pumping well is a system of three metallic conduits, casing, tubing and rods. These separate strings contact each other at various points down the well. All of these conduits are jointed with many connections of high resistance along the string. The path of the current will bypass connections of high resistance, detouring over to a string having lower resistance in that area. The path of the current down the well is a series of jumps from casing to tubing, to rods, back and forth. Metal is removed by electrolysis at each point where the current leaves one string to enter another. The flow line current is not only responsible for casing perforations but also for tubing and rod damage. When the flow line is parted or an insulating flange is inserted, the flow of current stops, just as no current flows when there is no metallic connection between the zinc and carbon of a dry cell battery. The current cannot bypass the insulating flange. The current cannot flow in both directions through one conductor, the earth. When the direct metallic connection to the well is broken by an insulating flange, the well is protected from electrolytic corrosion, the flow line current drain is stopped and the corrosion of surface equipment is reduced.

The properly installed insulating flanges in the flow lines at the wellhead of every well, is the cheapest and most effective method of protecting well equipment from electrolytic corrosion.

The numerous high resistance connections in the three strings of pumping wells makes the successful operation of cathodic protection questionable, since the applied current will transfer from casing to tubing, to rods. Bypassing high resistance connections will cause electrolytic corrosion at each spot of current transfer. The numerous high resistance connections in pumping well equipment strings makes cathodic protection an undesirable protection scheme.

Galvanic Corrosion. All handbooks of chemistry list the electromotive force series of the metals, lithium, sodium, etc. which corrode violently in water, at the top, then tin and lead which resist corrosion, and the noble metal gold at the bottom. The voltages listed is the tendency of the metal to react or corrode. The farther apart two metals are in the series the higher the voltage generated when they are immersed simultaneously in brine and metallically or electrically bonded, also the faster the negatively charged metal will corrode.

In a pumping well, the casing and tubing are of mild steel, the rods are usually a steel alloy or even chrome or nickel plated, the rod boxes may be a different steel alloy than the rods. Pumps made with a chrome plated working barrel in a mild steel body may have cast iron cages and

Chemical inhibitors seem to be answer to H_2S corrosion

stainless steel balls and seats. The ball and seat may even be made of different alloys. When these separate parts are immersed in oil field brine and connected by a voltmeter, the potentials measured shows the corrosion potential of one of the pieces. Some balls and seats so tested show a galvanic potential, while the boxes in the rod string are found to be electronegative to the rods. The mild steel barrel corrodes rapidly when in contact with a chrome plated working barrel.

Galvanic corrosion does not affect these various alloys as long as the well's production is free of water or brine. Most wells, however, produce some water even after a period of water-free production. After a period of trouble-free operation, the pump repairs become excessive, at the same time brine appears in the production. This is the time to examine the make-up of the well's equipment. Experience indicates that an all-steel or all-cast iron pump will give the longest service.

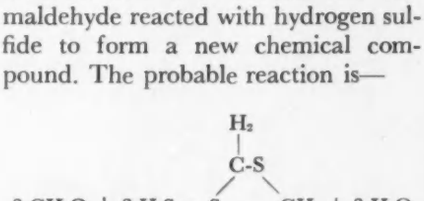
Chemical Corrosion. The iron in well equipment may be corroded by hydrogen sulfide to form an iron sulfide, which is its natural state. Corrosive hydrogen sulfide is present in fluids from many oil fields, especially those producing from limestone reservoirs. Mild steel equipment is particularly susceptible to attack. Alloying elements such as chromium and nickel, even in small percentages reduce corrosion rates.

Severe corrosion of pumps, tubing, rods and casing results when the well produces brine containing hydrogen surfide. As little as twenty to thirty parts per million of hydrogen sulfide can cause tubing perforation in a year, rod breaks in three to four months, and extensive pump damage. West Texas and New Mexico offer numerous examples of the surprising rapidity with which casing can disintegrate as a result of the hydrogen sulfide content of the produced fluid.

Hydrogen sulfide can be corrosive in a wide range of brine—acid, neutral, or even slightly alkaline. Small amounts of ammonium hydroxide or alkali added to an acedic sulfide brine increases corrosivity until the brine is neutralized then additional alkali reduces the corrosiveness. Sodium hydroxide, ammonium hydroxide, and amines are some of the alkalies used in brine treatment.

Remedial Measures. The use of chemical inhibitors appears to be the only economical remedy to reduce the sulfide corrosion damage of well equipment.

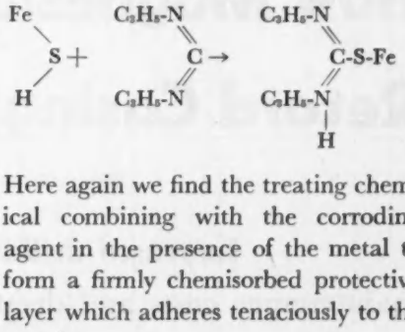
The writer discovered the peculiar property of formaldehyde to reduce the corrosive action of sulfide brines on mild steel. It was noted that formaldehyde reacted with hydrogen sulfide to form a new chemical compound. The probable reaction is—



This reaction product of formaldehyde and hydrogen sulfide can be prepared in the laboratory. It has been found, however, that this prepared chemical used as a sulfide corrosion inhibitor is only 30 percent as effective as the reactive formaldehyde. Evidence points to the conclusion that the most effective inhibition is obtained when the treating chemical reacts with the corroding agent to form the inhibitor in the presence of the metal being treated. Each treatment with formaldehyde will protect the metal for three or four days. The only objection to the use of formaldehyde is the objectionable odor of the formaldehyde-hydrogen sulfide reaction product.

This new concept of the most effective use of chemical inhibitors is further substantiated by the inhibiting property of the cyanamides to reduce sulfide corrosion. The cyanamides include calcium cyanamide, sodium dicyanamide, diallyl cyanamide, etc. The cyanamides are not to be confused with the cyanides which are poisonous. Tests show that 100 parts per million diallyl cayanamide, added to brines of PH 6.5 and 800 parts per million hydrogen sulfide, reduces the corrosion from .96 pounds per square foot per year to .07 pounds per square foot per year or a reduction of 93 percent. These tests were run for 14 days with only one treatment of the cyanamide. The results show a long life protection.

The cyanamides are reactive chemical compounds. They react with hydrogen sulfide to form thioureas which are known to be very effective inhibitors of corrosion. The mechanism of the inhibition of sulfide corrosion by cyanamides may be as follows—



Here again we find the treating chemical combining with the corroding agent in the presence of the metal to form a firmly chemisorbed protective layer which adheres tenaciously to the metal.

This type of chemical reaction, termed coordination, is well known. There are organic chemicals whose molecules are ordinarily in a stable existence, but they will combine with the molecules of another chemical to form a new compound. The new compounds are called coordinate compounds. The thioureas are quite prone to coordinate with metals or metallic compounds, providing an excellent protective coat. —**The End**

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Many types and sizes of magnesium anodes are used for cathodic protection of metal structures. For protecting casing, the long, high-potential anode being held in the center of the picture is usually the most efficient.

How Magnesium Anodes Retard Casing Corrosion

Increased drilling and completion costs, rising maintenance costs and deeper wells with longer lives add up to make corrosion protection a MUST.

By HUGH A. BRADY
Corrosion Services Incorporated
Tulsa

MAJOR oil companies have used magnesium anodes extensively during the past few years to protect oil well casing against external corrosion. Independent operators are also beginning to apply cathodic protection profitably to prevent casing corrosion.

The importance of protecting oil well casing can be seen when the cost of expensive repair jobs and the possible loss of producing wells are considered. The longer productive life of wells today because of proration and secondary recovery, the greater well depths and pressures, and the high cost of drilling and completing wells all make corrosion protection essential.

Causes of Corrosion. The principal causes of external casing corrosion are:

- Electrolysis caused by electrical current flowing down the casing from connected flow lines.
- Electrolysis caused by stray subsurface electrical currents.
- Electrolysis caused by galvanic action between dissimilar metals or dissimilar formations.
- Bacterial action.

These causes of corrosion can be controlled by controlling electrical current flow within the casing. Electrolysis (corrosion caused by an electrical current) occurs when a current flows from an anodic casing area into the soil and back to a cathodic casing area. A part of the casing acts as an anode, and the current flowing from it carries away minute particles of metal.

When a magnesium anode is placed

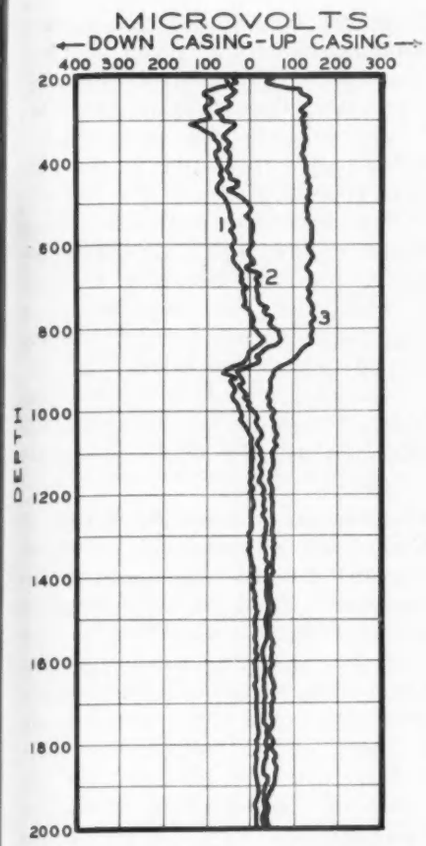

FIGURE 1—Well casing potential profile on a Kansas well: (1) flow line connected, (2) flow line insulated form casing, (3) casing cathodically protected by magnesium anodes. Anodic or corroding areas fall to the left or zero on the profile.

in the ground at a distance from the casing and connected to the casing by an insulated copper wire, the magnesium becomes the anode. The higher electrical potential of magnesium causes a current to flow from the magnesium anode to the casing. This controlled current protects the casing, but the sacrificial anode corrodes. The action of the anode has made the casing, in effect, a cathode, thus the term cathodic protection.

The changed direction of current flow can set up an alkaline environment around the casing, which stops or retards bacterial corrosion. Insulating the casing from surface lines prevents a flow of surface current down the casing, thus controlling this form of electrolysis. The flow of current from the magnesium anode to the casing, then through the copper wire back to the anode also stops electrolysis caused by galvanic action or by stray subsurface currents.

When Should Magnesium Anodes Be Used? The use of magnesium anodes is recommended whenever (1) external casing corrosion problems are discovered in a field, or (2) casing potential surveys reveal serious anodic areas in the casing.

Cathodic protection should be applied as soon as possible after a corrosion problem is found so that further external casing corrosion can be prevented and casing repairs can be avoided. Often a casing potential profile will show that serious corrosion can be expected in areas where no casing failures have yet occurred.

Casing potential profiles or surveys show which points in a casing are cathodic and which are anodic. Cathodic areas pick up current from the soil, while current flows from anodic areas into the soil.

Such surveys are run from the bottom of the casing up, using a down-hole tool which measures the difference in electrical potential between two contact points spaced from 10 to 25 feet apart. A typical example of such a profile is shown in Figure 1. Anodic or corroding areas on the casing have a negative current, indicating that current is leaving, rather than entering the casing. Such negative currents are to the left of the zero point on the profile. Cathodic or non-corroding areas have positive currents, which are shown on the profile to the right of the zero point.

It can be seen from Figure 1 that much of the casing area above 1060 feet is anodic in the first curve. This curve shows the conditions within the casing when the surface flow line was connected, without insulation, to the casing. Curve 2 shows the change brought about by insulating the casing from the flow line. Curve 3 shows the result of protecting the casing cathodically by using magnesium anodes.

Field experience has been that areas shown to be anodic in casing potential surveys usually suffer severe corrosion. When casing has been pulled and inspected carefully, it has been found that the portions of the casing corresponding to anodic areas, as shown in the potential survey, have suffered serious corrosion. Such casing potential surveys are a dependable method for predicting ocurrence of external corrosion caused by electrolysis.

Determining Current Needed for Cathodic Protection. Usually the first step in planning cathodic protection for casing is to determine by means of a log current-potential survey what the current requirement is for an individual installation. This is done by applying, incrementally, increased current to the casing and measuring the electrical potential of the casing, at each current level, relative to a remote earth point.

The resulting curve is placed on a semi-log graph. The curve is a straight

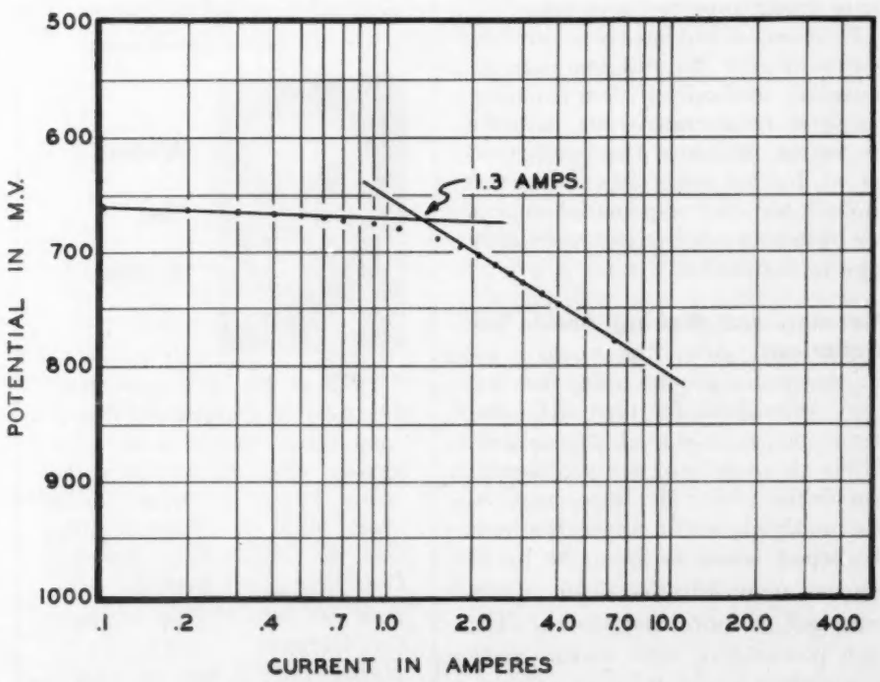

FIGURE 2—A typical log current—potential profile for determining cathodic protection current requirements for well casing. In this case 1.3 amps should provide protection.

FIGURE 3—This schematic drawing shows how buried magnesium anodes are placed in beds and connected to the well casing. Each anode is surrounded by a special low-resistance backfill.

line until enough current is applied to prevent corrosion, when it turns and becomes a straight-line function of the logarithm of the applied current.[3] The point at which the straight line portions of the curves intersect indicates the current required. Figure 2 is a typical curve of such a survey. In the particular well from which this data came, a current of 1.3 amperes should provide protection.

Field experience has borne out laboratory theory on this log current-potential method of determining current requirements for cathodic protection. Evidence that wells protected by the current indicated through log current-potential surveys has been obtained from several widely separated areas.[1]

Planning and Making Anode Installations. After the current requirement for proper protection has been determined, the type and number of anodes to be used is calculated. Although pure magnesium anodes can deliver relatively large currents, a new high-potential anode has been developed which is from 20 to 30 percent more effective than anodes composed of pure magnesium.[2] The high potential of these anodes make it possible to use fewer anodes to provide a given current, or to obtain a higher current output from a given number of anodes.

The placing of the anode beds depends on the resistivity of the soil, the current desired, and the depth to which the casing is to be protected. In most cases, the anode beds are placed a minimum of 100 feet from the well head. The anodes are usually placed from 15 to 20 feet apart, in vertical holes drilled by augers. The holes are larger than the anodes, allowing space for a backfill composed of a special low-resistance material. The tops of the anodes are connected by an insulated copper wire, which is connected to the casing at the wellhead (Figure 3).

New engineering methods and magnesium anodes with high driving potential now make it possible to determine definitely the minimum current which will be produced by an installation of anodes. This makes it possible for an operator to be sure, in advance of the installation, that his casing will receive a current of the necessary strength.

Magnesium Anodes At Work. A Gulf Coast oil producing company recently installed magnesium anodes to protect 62 of its wells from external casing corrosion. Five of these wells were in a salt water bay. Casing potential surveys showed that cathodic protection could be extended to the full depth of 5500 feet.

A log current-potential survey was run. It indicated that current requirements varied over a wide range from 0.5 to 6.2 amperes. High-potential anodes were installed in ground beds containing from two to 16 anodes each. The cost to the company for installing anodes designed to deliver cathodic protection for ten years ranged from $215 to $510 per well.

Another company provided cathodic protection for 132 wells in Oklahoma at a cost ranging from about $150 to $350 per well. These wells were producing from three different sands, the Bromide at 5000 feet, the McLish at 5800 feet, and the Oil Creek at 6500 feet. The wells are all single completion wells, and the 7-inch casing in each is set on top of the producing sand. The length of casing being protected from corrosion varies from 5000 to 6500 feet. The number of anodes needed per well was from six to nine. The installation was designed to provide protection for ten years. At the end of that time, new magnesium anodes can be provided at considerably less than the original installation cost because no engineering work or rewiring will be necessary.

About the Author

HUGH A. BRADY received an electrical engineering degree from Oklahoma A. & M. College in 1942. He served in the Army Engineer Corps during World War II. Following the war, he joined Gulf Refining Company as an electrical engineer. He became chief engineer for Corrosion Services Incorporated in 1955, and was named assistant manager in 1956.

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[2] George, P. F., Newport, J. J., and Nichols, J. L., "A High Potential Magnesium Anode," *Corrosion*, Vol. 12, No. 12, Dec., 1956, p. 627t.

[3] Titterington, Y. W., "Theory and Application of Cathodic Protection to Well Casing," presented at NACE Conference, San Antonio, Texas, Oct., 1956.

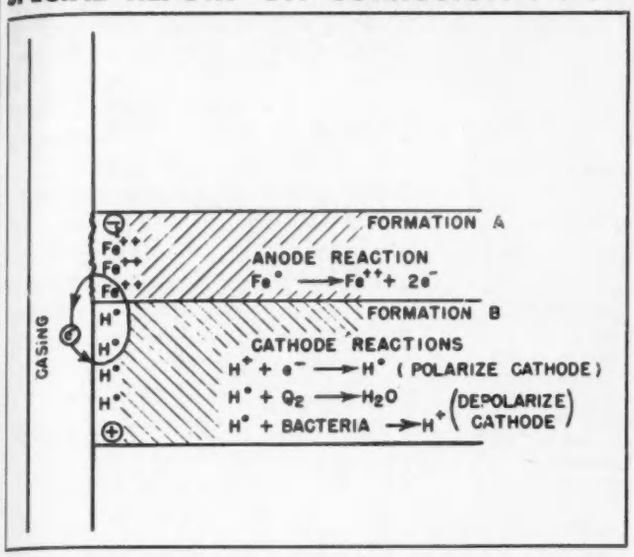


FIGURE 1—Schematic illustration of the action between two formations resulting in electrochemical corrosion of casing.

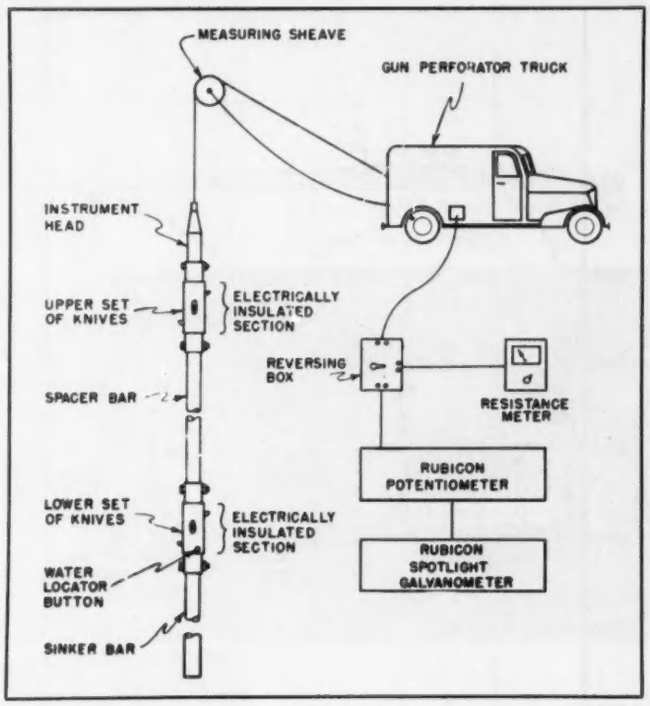


FIGURE 2—Sketch of equipment used in obtaining a plot of the casing potential profile—a check on the electrochemical action.

External Casing Corrosion: Cause, Effect and Control

Casing corrosion costs millions and N.A.C.E. surveys indicate that external causes account for from 70 to 80 percent of total.

By J. D. SUDBURY
Continental Oil Company
Ponca City, Okla

THE OIL AND GAS industry spends approximately $650 million a year for casing. According to a survey by the National Association of Corrosion Engineers the industry is spending millions of dollars annually in direct costs due to casing corrosion. Individual repair jobs may cost from a few hundred dollars to $100,000. In addition casing failures often cause:

- Premature abandonment of wells due to inability to effect repairs or, more often, inability for a low producing well to pay out an expensive workover job.
- Pressuring of shallow water sands from gas producing formations. This is a definite safety hazard and may result in expensive lawsuits.

Other ill effects may be cited but these two emphasize the magnitude of the problem and the concern with which it is viewed by the industry.

CAUSE

Types of Casing Corrosion. External corrosion has been ascribed to an electrochemical type of attack resulting from a current transfer caused by a potential difference between two parts of a well. These potential differences may be between:

- Casing in contact with one formation and another.
- Casing in contact with one formation and a mud cake.
- Surface flow line and casing.
- Surface pipe and casing.
- Areas of dissimilar metallurgy.

Figure 1 shows electrochemical action between two formations, *A* and *B*.

In the anode area, oxidation takes place as iron ions go into solution in Formation *A* as a product of corrosion. In the cathode area reduction takes place and hydrogen atoms are formed at the boundary between the pipe and Formation *B*. The flow of electrons is into the pipe at the anode or corroding area and out of the pipe into the formation at the cathode. (For those who think in terms of conventional current, the direction of current flow is reversed). As this battery action takes place, the layer of hydrogen developed on the cathode offers a resistance to the flow of current in the cell. The cathode, thus, has been polarized. This polarizing film can be removed by the addition of a depolarizing agent which reacts with and removes this hydrogen film. Such an agent must be present in order for this corrosion reaction to proceed at a rate sufficient to cause a severe corrosion problem.

Two common depolarizing agents are:

- Oxygen which reacts with hydrogen.

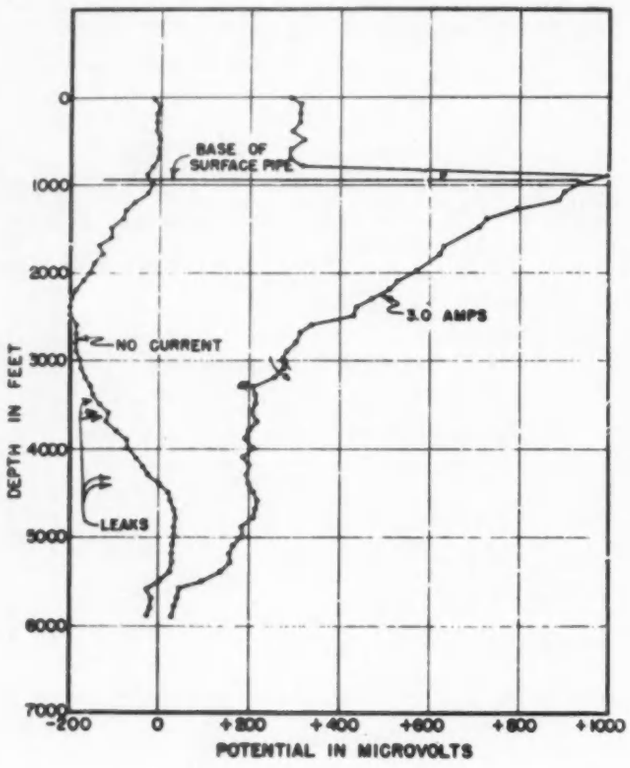


FIGURE 3—A sample casing potential profile of a well in San Miguelito field, California, showing the left or anode slope (corrosion areas) and the right, cathode slope with and without cathodic protection.

- Certain bacteria which use atomic hydrogen as part of their life process.

When the surface line pipe or a portion of the casing or surface pipe down to a few hundred feet in the well is the cathode, oxygen is the obvious depolarizing agent.

When the cathode is at greater depths it seems likely that the sulfate reducing bacteria are a major factor in casing corrosion. They may originally be in the wells or be introduced through the mud system. The role of sulfate reducing bacteria as a factor in causing corrosion is still controversial. But to doubt their role as cathodic depolarizers is to ignore the results of significant research undertaken by competent corrosion engineers.

EFFECT

Measurement of Electrochemical Corrosion. Where cells of the type described in Figure 1 operate over appreciable distances it should be possible to measure the currents flowing in the pipe as an IR drop over an interval of pipe. Such measurements can be made by using the *casing potential profile.*

Figure 2 is a schematic drawing of the measuring equipment. Measurements of IR drop are made between tungsten carbide-tipped knives (usually placed 25 feet apart). The potential readings are made using suitable potentiometer equipment at the surface.

A plot of these potential differences versus depth of well has been designated as a *potential profile.*

Figure 3 is a typical profile which shows data from a well in the San Miguelito field, California. A slope upward to the left indicates an anode area in which electrons are entering the pipe (i.e. conventional current leaves the pipe). Where the curve slopes upward to the right, electrons are leaving the pipe creating a cathode area. Where the curve is vertical no current transfer is occurring and there is neither anode nor cathode area. The pipe merely serves as a conductor.

This profile records only the gross cells operating over appreciable distances but does not record microcells operating within the 25-foot spacings. Despite this limitation it is the only tool that provides an idea of the nature of external corrosion. Analysis of the SP log has been suggested but so far has not proved a tool of real practical value.

Referring to the profile in this well, a long anodic slope is noted from 2500 to 4600 feet attributed to a large number of water zones in the well. Casing was recovered to a depth of 5200 feet. Seventeen holes were found in the interval from 3200 to 3700 feet and one at 4400 feet. Severe pit type corrosion was formed in the interval 2200 to 4600 feet. This is approximately that interval defined as corrosive by the profile.

Figure 4 shows a section of the most severe corrosion. The corrosion

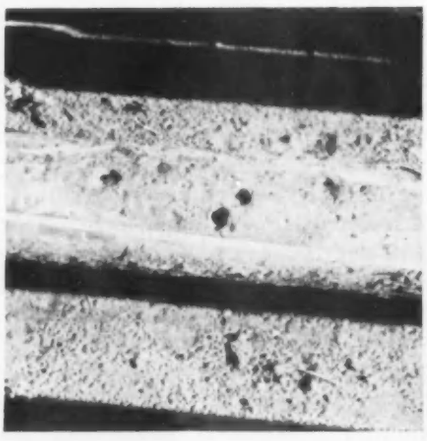
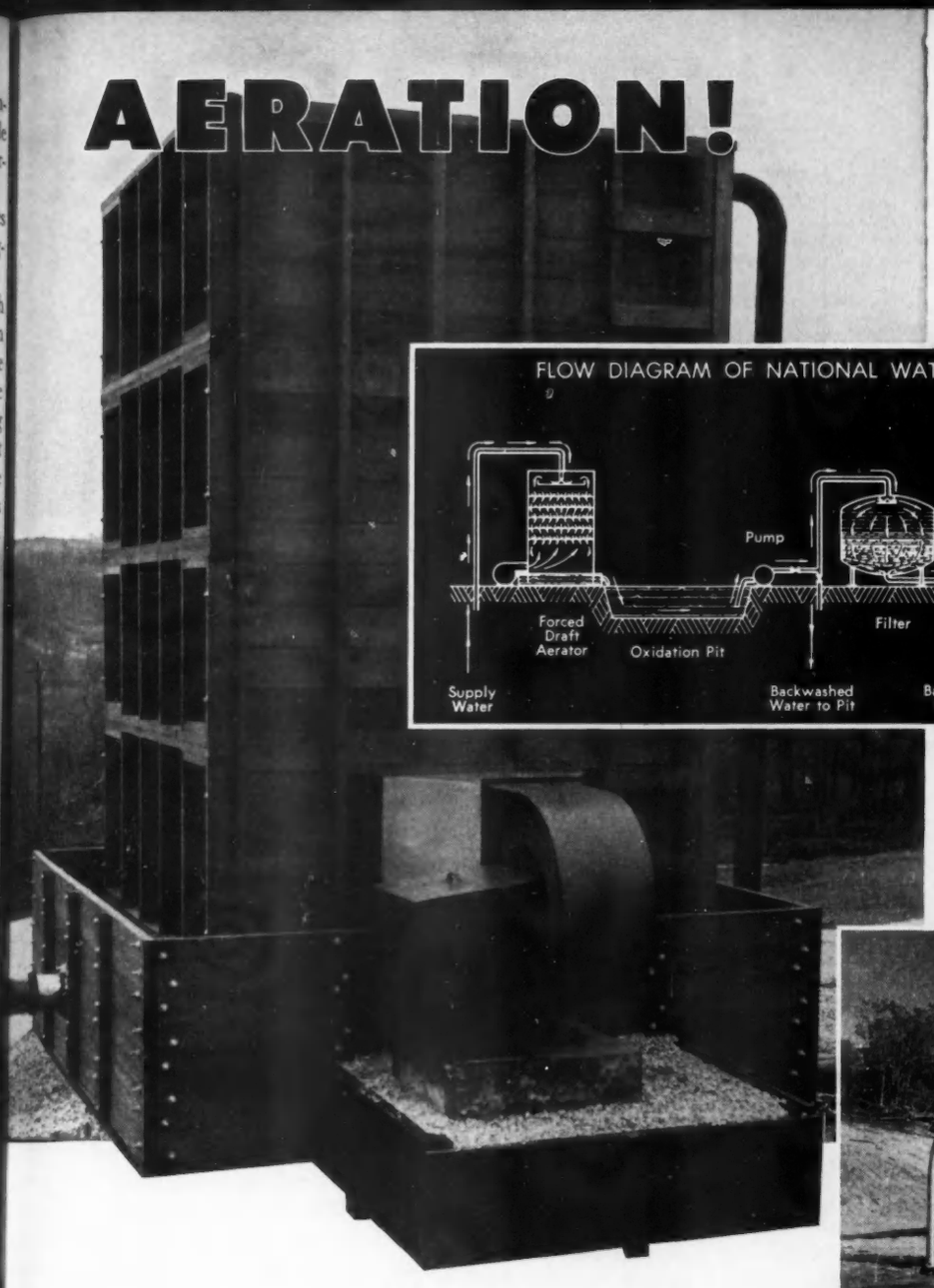


FIGURE 4—A section of casing subjected to severe corrosion. The corrosion product was an unidentified iron chloride.

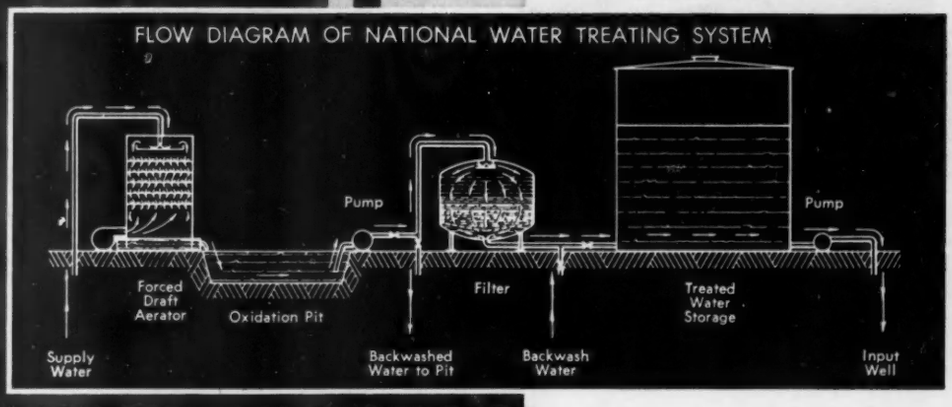
FIGURE 5—A heavy mud layer made an excellent conductor which assisted in the streaked corrosion of the pipe.

FIGURE 6—An illustration of the severe crevice corrosion that occurred at every joint within a defined corrosive zone.

AERATION!



National Aerator for treating supply water or disposal water in open water system.



Two National Aerators in series with water supply well located north of Tulsa, Oklahoma.

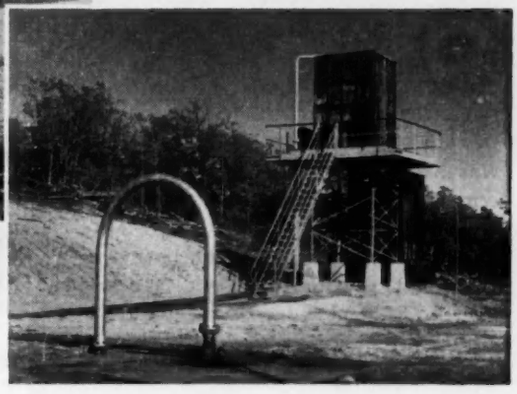


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FIGURE 7—Smooth corrosion in the entire interval below the surface pipe might well be the result of "Gross" cell corrosion.

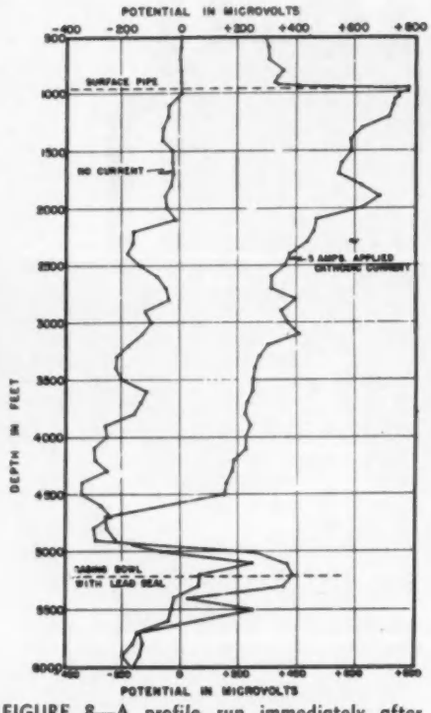


FIGURE 8—A profile run immediately after new pipe was set shows several gross cells operating in the span from 2400 to 4600 feet.

FIGURE 9—Calcareous films and cement cover large portions of the pipe making current requirement calculations difficult.

product was shown to be an unidentified iron chloride.

Figure 5 shows how corrosion occurred in streaks along the pipe. These areas were covered with a heavy layer of mud which served as a good conductor.

Figure 6 shows severe crevice corrosion at every joint within the defined corrosive zone. Corrosion occurred on both the pin and collar so the effect is probably one of the crevice and not of a metallurgical difference between collar and pin. In addition to this severe pit type corrosion there was also a much less severe, smooth corrosion in the entire pipe interval below the surface pipe. (See Figure 7). The corrosion product here was identified as Siderite ($FeCO_3$) and Pyrite (FeS_2).

These two types of corrosion might well be the "gross" and "micro" cell corrosion to be discussed later. In this case the gross problem is some four times more severe than the other.

The profile did not predict the extreme severity of corrosion in the 3200-3700-foot interval. However, the qualitative correlation must be considered good.

Figure 7 indicates the gross cells contribute the very severe corrosion and the microcells the very definite but less intense corrosion. Corrosion identified by the profile was giving the most trouble.

Figure 8 shows a profile run immediately after new pipe was set in the well. Instead of a single long anode, several gross cells are operating in the pipe span from 2400 to 4600 feet. These correspond roughly to different water zones. Apparently some time is required for establishment of the equilibrium cell. There is also a cell built up around the lead seated casing patch.

CONTROL

Determination of Current requirement. A number of methods have been postulated for estimating the current required for cathodic protection:

1. Determine current required to remove anodic slope of potential profile. Result of this method is shown on the profile (Figure 3). The bulk of the anodic slope was eliminated by the application of three amperes of current. Actually, several different currents were run. The effect of either greater currents or greater time was to make the shift more pronounced and the curves smoother. It seems logical that the gross currents have all been eliminated when the gross anodic slope has been eliminated. However this shows only that the gross currents have been eliminated but fails to show whether micro currents within the 25-foot spans have been eliminated. Thus, the erasure of the anode slope is *not* proof of the elimination of corrosion although experience indicates their removal will reduce a major amount of corrosion. Based on this method necessary current requirements from 1-7.5 amperes have been shown for depths from 600 to 8000 feet.

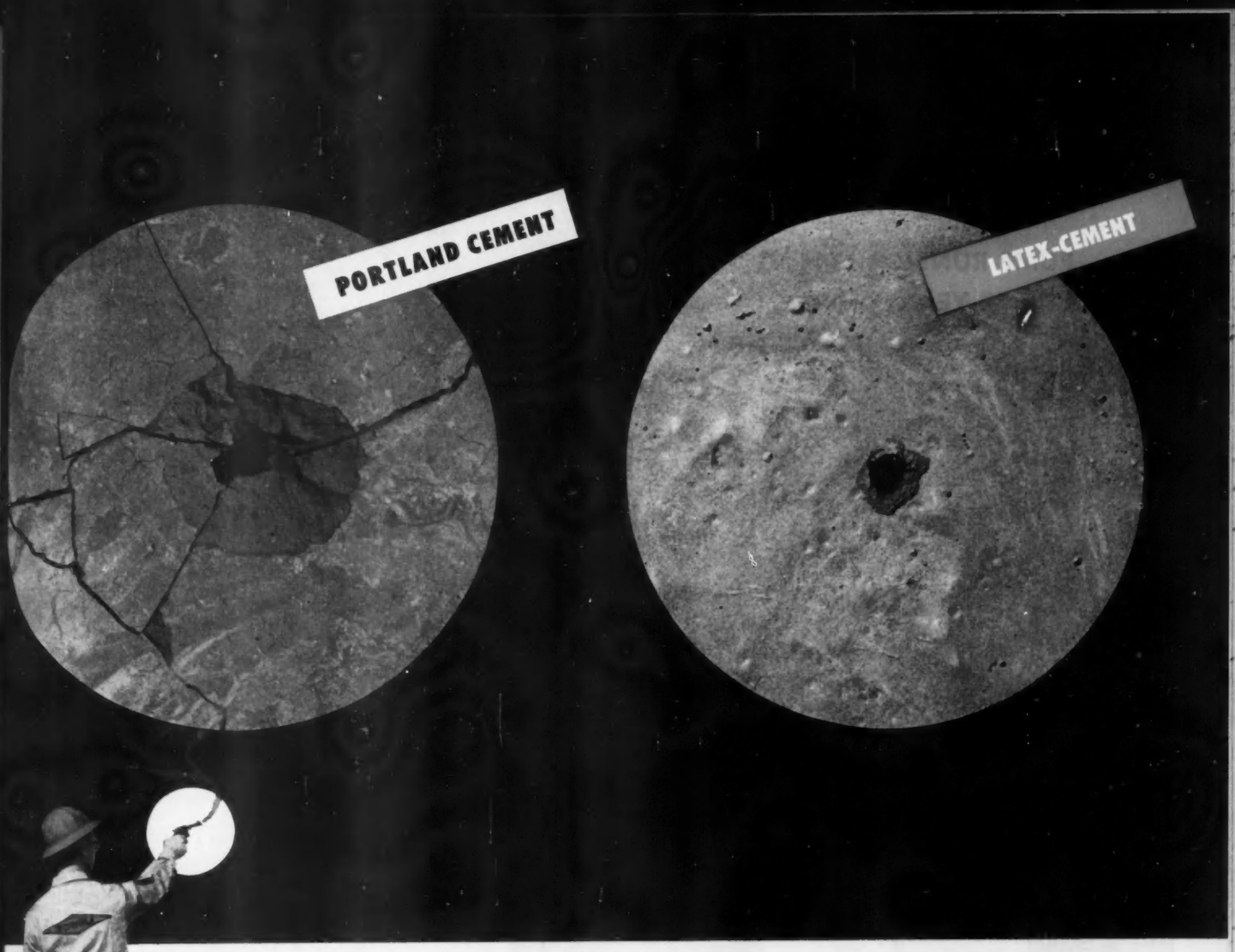
2. A simpler approach is the log current-potential method, involving measurement of polarization rates based on surface potential requirements. A break in the plot of E vs. Log I is taken as the current required for cathodic protection. In shallow fields this method has given numbers equal to or smaller than the current as required by the potential profile. In the writer's opinion this technique gives the current density at which polarization begins and tells little about the depth to which protection must be extended. This method probably has its greatest application for shallow wells.

3. Calculations based on SP curves and of astronomical current requirements. The writer has little faith in the final result of this method believing serious basic errors have been made.

4. Calculating 2-5 m.a. per square foot as the current required for cathodic protection of surface equipment; for 5000 feet of 7-inch pipe a current requirement, assuming equal current distribution, of nine amps of protective current would be required for each m.a./ft.^{2} There are many reasons to believe, however, that this calculation is not valid since there is a large portion of the pipe covered with paint, calcareous films and cement. (See Figure 9).

5. Down-hole casing-to-soil potentials in the same manner as pipe-to-soil potentials in pipe line work. A shift of 0.2-0.3 volts is taken as an indication of protection.

6. Long term field tests. These must be undertaken to determine the effectiveness of various methods. Finally, laboratories must continue extensive



Here's one reason why CEALMENT has given better cement jobs

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Laboratory tests and field experience indicate that the same thing may happen in your well. Cealment is especially useful for cementing a thin oil zone with gas or water nearby.

Resiliency is only one of many advantages of latex-cement. It bonds better, sets more dependably, and has shown excellent resistance to contamination by well fluids. More and more operators are finding that they are money ahead when they use Cealment.

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PUMP RUNS CONTINUOUSLY FOR 32 YEARS, RODS 50 YEARS

The following information was taken directly from P. D. Quinby Oil Company's files on their Well #2, McKittrick, California (shown). On Jan. 12, 1922, an Axelson TL Pump 2″ (1¾″) with regular cast iron liners and regular steel plunger was run into the well. It ran 24 hours a day for 32 years at 9 strokes per minute. When pulled for the first time in June, 1954, liners and plunger were worn (after 307,152,000 plunger reversals) but balls and seats were in excellent condition.

A new Axelson pump was run back into the well on the same Axelson sucker rod string that had been installed originally in 1905 when the well was completed—over 50 years of continuous sucker rod service!

HASH STRIPES. C. E. "Earl" Gwin (right), Production Foreman for P. D. Quinby Oil Company, holds the barrel of the Axelson pump that saw 32 years of uninterrupted service. Orian Myers, well puller, sits beside the plunger assembly. Balls and seats showed very little wear. The new pump is strapped to the car.

MUSEUM PIECE. Lee Kulzer, Axelson District Manager, inspects the Axelson sucker rods which were installed in 1905 and are still going strong. The first metal rods were ¾″ and ⅞″ iron bars with bolt threads on each end. Bolt-threaded couplings held them together. When rods parted, the broken end was cut off with a hacksaw and the end rethreaded with a bolt-thread die. The rod was screwed into the coupling and run back into the well.

LEADERS. In front of the Axelson pump rack at the J&L store at Freer, Texas, are Lee Rodgers (left) and Bryan Weaver, Production Superintendent for the Estate of A. A. Buchanan. Rodgers opened this pump shop 22 years ago and for 5 years (1949-54) led all 90 stores in the J&L organization for sales of Axelson pumps and parts. Weaver was Superintendent for Magnolia in Electra, Texas, back in 1924 and used to buy 12 Axelson pumps at a time—"They were cheaper by the dozen, then," he says.

117 YEARS. These three old timers, caught chinning in the pump repair shop at Jones & Laughlin's Shreveport store, Louisiana, have been around the oil fields a few years. Hugh White (left) has been with J&L the past 36 years and 4 years with Gulf Oil prior to that. Cleon Worley (center), Axelson District Manager, has been with Axelson for 31 years, 6 with Continental Supply and 7 with Prairie Oil & Gas. J. A. Evans, Jr. (right) roughnecked for 3 years before starting on a 30-year career with J&L. It all adds up to 117 productive years in the industry.

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HARD WORKER. An Axelson Volu-Max (Maximum Volume) 2½" pump is being run in on the rods to lift 500 B/D of fluid with 30 bbls. of 24 gravity oil. Fluid level is at 900 feet. Cycle is 20 strokes per minute, 40" stroke. This well is in Trinity Field, Texas. Boone Bros. Oil Company is the producer. Volu-Max Pumps are recommended for this kind of hard, fast, high-volume, poorly lubricated pumping.

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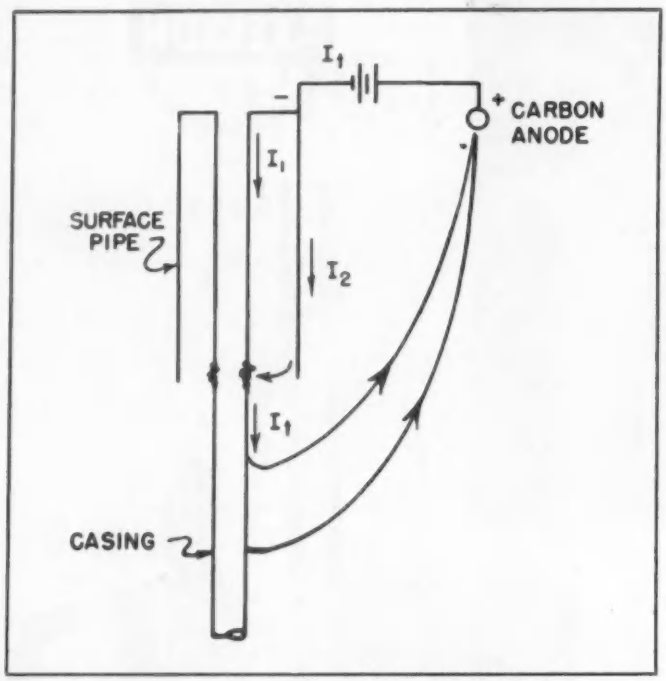

FIGURE 10—This diagram illustrates the surface pipe effect. Current applied to the casing goes down the casing on the surface pipe.

experiments to help determine accurate current requirements to prevent casing corrosion under varying conditions.

Evidence of Effective Cathodic Protection: If cathodic protection is effective it would be expected that a calcareous scale should be formed as the casing is made cathodic.

Humble Oil & Refining Company reports the presence of a calcareous deposit in wells that had been cathodically protected for one year with currents from 0.5-10 amps. Evidence of such a deposit in the bottoms of pits underneath the corrosion product was reported and, if true, this is very significant.

Stanolind Oil and Gas Company reported a tremendous shift to depths of 1800 feet in the potential profile after a year with 1.2 amps applied. This was taken to indicate that a cathodic scale was being formed and the surface area of pipe to be protected was being effectively reduced.

Continental Oil Company reported indications of a calcareous deposit to depths of 5000 feet in pipe pulled from a well in the San Miguelito field, California, after applying five amps for six months. In another field where the company applied three amps cathodic protection to the most troublesome areas there is evidence that the frequency of failures has tapered off. Because of many factors involved it is not certain whether this tapering is yet significant.

The above reports hint that cathodic protection of casing is having some effect, but to date there is no unqualified proof to show the extent of this effectiveness.

Some Problems in Use of Cathodic Protection

A. If currents in excess of a fraction of an amp are required, a source of electrical power is necessary, other than magnesium anode. This becomes a problem on non-electrified leases.

Some possible solutions:

1. Wind generators—not believed practical because of (a) lack of wind control; (b) high initial cost; (c) high maintenance costs.

2. Use of other DC generators. On pumping wells DC generators have been effectively driven off the pumping beam. In flowing wells producing abundant gas a DC generator can be driven by an air motor.

3. Storage batteries.

4. Arrange with a power company to string lines to the well site.

B. Interference of adjacent wells, can be eliminated as a problem by protecting all adjacent wells.

C. Surface pipe effect. Figure 10 shows that when current is applied to the casing it either goes down the casing (I_1) or the surface pipe (I_2). Some of I_2 returns to the ground bed. Some of I_2, however, apparently transfers from the surface pipe to the casing. This is proven by the very sharp break in the potential profile at this point. Referring to Figure 3, this very sharp break is noted at the base of the surface pipe as the transfer occurs.

If this current transfer is by an electrochemical path, serious corrosion will occur. If it is through a metallic conductor due to casing resting against surface pipe there will be no adverse effects. There is evidence to support this statement and the data to date make it appear highly unlikely that any serious surface pipe effect will occur as long as sufficient current for protection is being applied.

Summary

A. Factors known about cathodic protection to prevent casing corrosion:

1. A large percentage of casing corrosion failures are due to an electrochemical attack on the exterior of the casing.

2. Corrosion is due to both "gross" and "micro" electrochemical cells.

3. The "gross" cells can be measured by the use of the potential profile. "Micro" cells cannot be measured.

4. Most external corrosion failures to date have been in regions of "gross" anodic nature.

5. Sufficient cathodic current should effectively stop corrosion.

6. The minimum current required to stop corrosion will be that required to erase the "gross" anodic slope *plus* an additional amount to stop the "micro" cells.

7. There will be no known adverse effects to the use of this protective current.

B. Factors not yet known and upon which future investigation should be directed:

1. Minimum current required to erase "gross" and "micro" cells.

2. Statistical proof that cathodic protection actually reduces casing failures.

3. The most practical and economical means to supply current to wells in non-electrified areas.

4. Tool or method for determining conditions of pipe in a particular well so as to provide a rapid evaluation of cathodic protection measures.

5. The over-all economics of cathodic protection.

In conclusion, cathodic protection appears to offer the best means in economically preventing casing corrosion in existing wells. —**The End**

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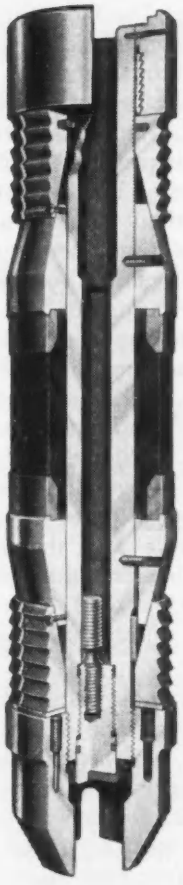

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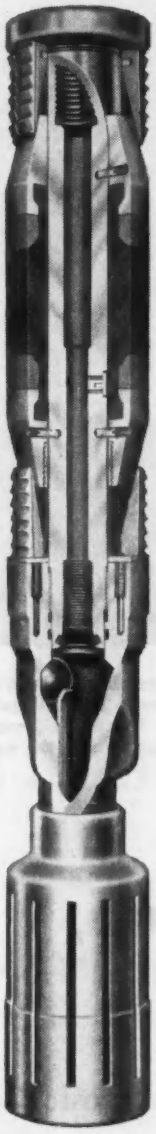

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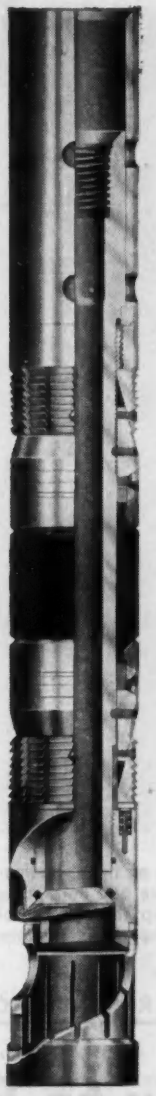

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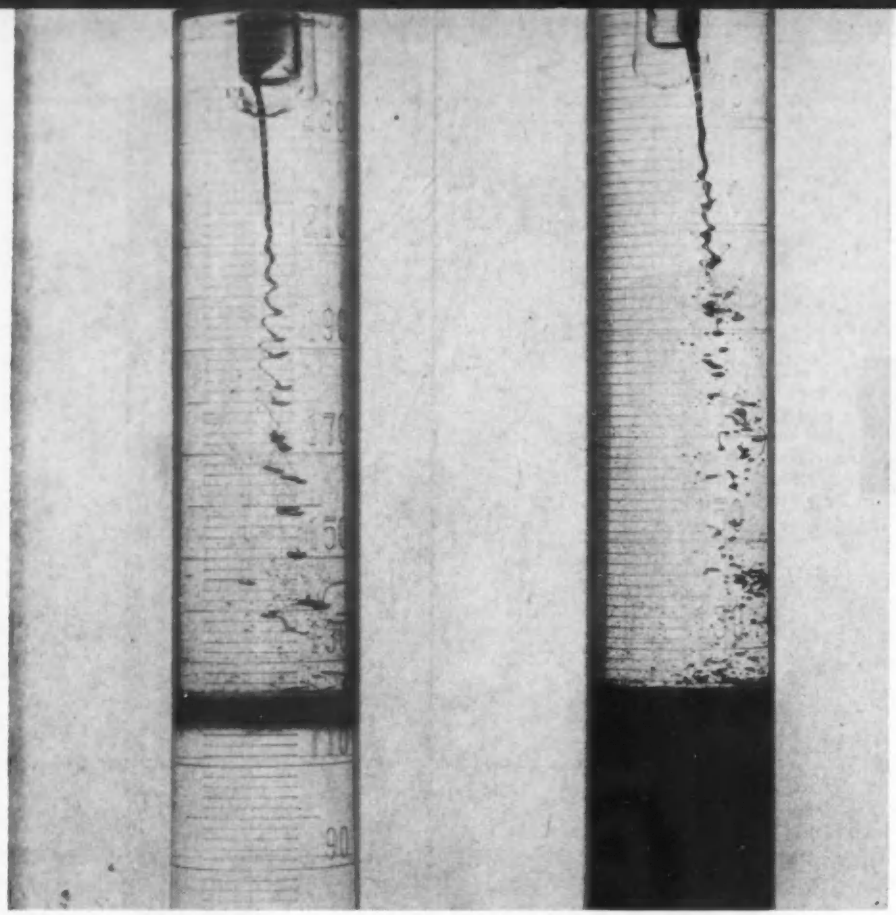

The action of the corrosion inhibitor is illustrated by the graduates above. The fluid column is half kerosine and half water, simulating most Kansas wells in corrosive areas. Regular inhibitors, at left, drop through the oil, but stop at the oil-water interface. The new oil-insoluble, water-dispersible inhibitor falls through the oil, then disperses quickly into the water.

Special Report on Corrosion

How to Stop Corrosion, But Not Production

A new method of applying corrosion inhibitor now being used by Kansas operators provides positive protection without the necessity of circulating the well. This method reduces to a minimum the time required to treat a well.

By E. G. STEVENS
Dowell Incorporated
Tulsa

MANY KANSAS OPERATORS now protect their pumping wells from corrosion by a new application method based on using a heavy, water-dispersible, oil-insoluble inhibitor. This new method has reduced the time required for treatments and provided more uniform protection. In marginal wells, this method has also saved production which would otherwise have been lost while the well was shut down to circulate the inhibitor.

Inhibitors are commonly applied in Kansas by batch-dumping the inhibitor into the annulus, then circulating the well for a period of time long enough to turn the well fluids over once. In the many marginal wells in Kansas which do not produce their allowable, this procedure causes the operator to lose the production which could have been made during this time. By contrast, the new application technique does not require that the well be circulated.

In this method, the annular space is first preflushed with five to ten gallons of well fluid, then the inhibitor is batched into the annulus. (The amount of inhibitor used and its cost are about the same as for other inhibitors.) It then falls rapidly (about 20 fpm) through the oil without dissolving, but immediately disperses when it enters the water. It is then produced with the well fluids through the tubing and pump, coating and protecting all metal surfaces. In effect, once the inhibitor is placed in the annulus, the well treats itself.

One advantage is that it is unnecessary for the pumper to remain at the well. This provides a substantial saving in time. This self-treating feature brings about another advantage. Because it is not necessary for the well to be circulated, positive protection is always afforded. The possibility of human error or neglect in improperly circulating the well is no longer a hazard. A third advantage is that the well continues pumping, with an almost negligible production loss. In these marginal wells, this represents a clear profit to the operator equal to the value of the oil produced during the time that circulation of the well would have been necessary with another type of inhibitor.

For example, if a well makes 24 barrels of oil a day and is circulated for three hours after each inhibitor treatment, the operator is losing three barrels of oil each time he treats. Most operators treat each well twice a week. Therefore, the operator is probably losing six barrels of oil a week which could be saved by using the new treating technique.

This inhibitor was first used north of Hays, Kansas. The treating method was then much the same as that used with other inhibitors. The wells were preflushed to wet the annular space, then the treatment was applied, followed by a circulation

Continued on Page 189

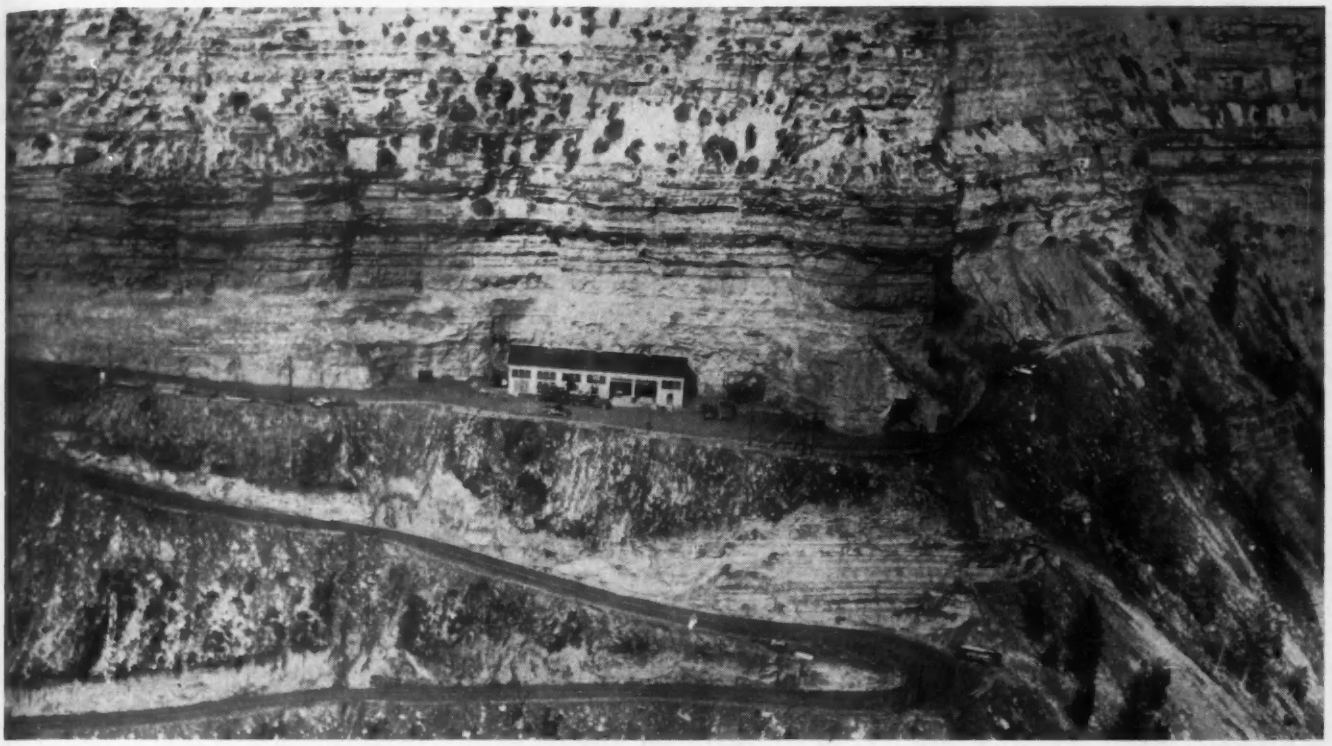

FIGURE 3—This is a close-up of a typical oil shale cliff taken at the portals to the Bureau of Mines experimental mine northwest of Rifle, Colo. The shale cliff immediately above the shed is one of the richer of the oil shale beds.

Don't Overlook Oil Shale

The rising cost of discovering and producing oil from wells in the U. S. is causing the proposition of producing from oil shales to appear more attractive.

By EARL TRAGER
H. Zinder & Associates, Inc.
Houston

CONSIDERABLE ATTENTION is being given the hundreds of billions of barrels of oil in the various oil shale deposits throughout the U. S. The location and extent of much of this reserve is already known. Only the cost of present extraction methods has kept shale oil from a competitive position in the petroleum market.

This situation seems to be changing, however. Increased material and labor costs, expensive discovery outlays, fantastic lease prices and mounting political tension are raising the cost of oil produced from wells. If this trend continues and shale oil extraction methods improve at the present rate, shale as a source of oil in the U. S. may come to life sooner than we think.

The name "oil shale" is misleading in that many people obtain the impression that oil is present as such in the shale and can be removed by simple extraction or by the use of solvents. Actually shale oil is formed only by heating the oil shales. Heating converts the source material, called kerogen, into oil.

Part 2

Oil shales are principally an inorganic marlstone composed of dolomite, calcite and some silica with thin beds of volcanic ash and various amounts of finely comminuted organic matter. The greater the amount of organic matter the greater the yield of hydrocarbons.

It is thought that these sediments accumulated in the fresh water of a large epicontinental sea far removed from high land. A microscope reveals in addition to the unidentifiable organic matter the presence of fragments of chitins, leaves, resinous material, spores, pollen grains, algae, fern fragments, portion of insect wings, bacteria protozoans and fish remains. The total organic material may represent up to 50 percent of a sample.

Laboratory Study of Samples. Upon the completion of the field work previously mentioned there followed nearly one year of laboratory study of the samples. A generous sample of each bed had been shipped to Bartlesville, Okla. Most of these samples were collected to represent about three feet of thickness.

A laboratory distillation setup was designed and this was checked by the chemical laboratory before the samples were redistilled under more carefully controlled conditions than the field retort. The chemical laboratory ran pilot check distillations on 100-pound and 500-pound samples to de-

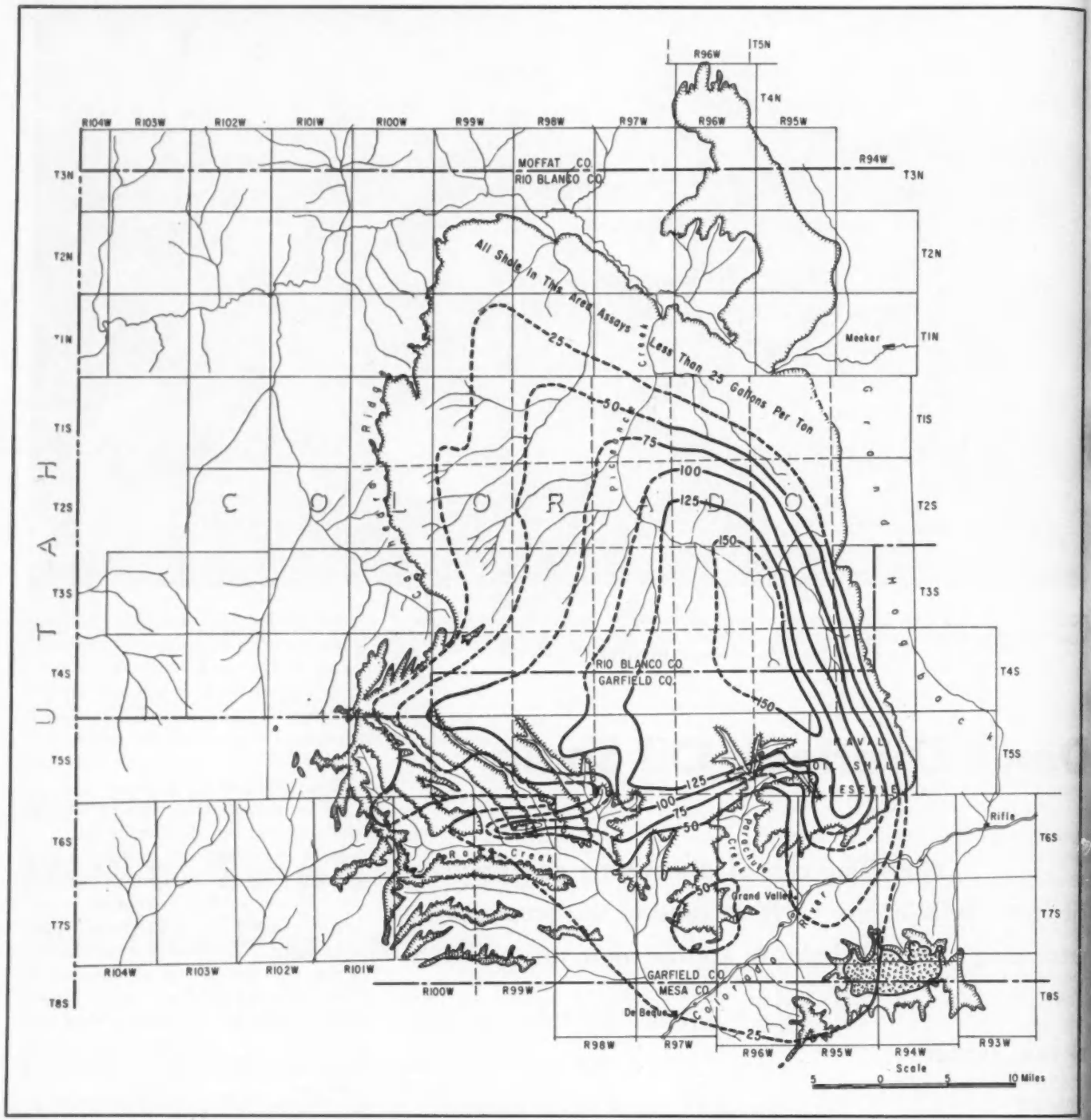

FIGURE 4—Isopach map of the oil shales of northwestern Colorado. The contours indicate the total thickness of oil shales which yield 25 gallons or more of shale oil per ton.

termine if the proposed laboratory method gave results approximating those of commercial recovery.

In making the final laboratory analyses the following data were determined for each sample: the shale oil yield in gallons per ton, its gravity, the cubic feet of flammable gas per ton of shale and the number of pounds of recoverable ammonium sulphate per ton of shale. In addition the percent of fixed carbon in the spent shale was also measured for some samples since this carbon might be a source of heat for the retorts in commercial practice.

Research distillations were conducted on several oil shales for which large samples were available. This research consisted of variations in the distillation technique, e.g., the introduction of oxygen, hydrogen and steam into the retort during distillation, the use of a vacuum, altering the size of fittings and condensers and different end temperatures.

Fourteen variations were used in distilling duplicate samples of shale No. 943 and the yield of shale oil ranged from 25 gallons to 45 gallons per ton. The shale oil resulting from the different processes was not of uniform quality.

Twelve variations in the method of treating sample No. 944 resulted in yields ranging from 50 to 72 gallons per ton.

One of the most effective methods was to distill the sample dry, then

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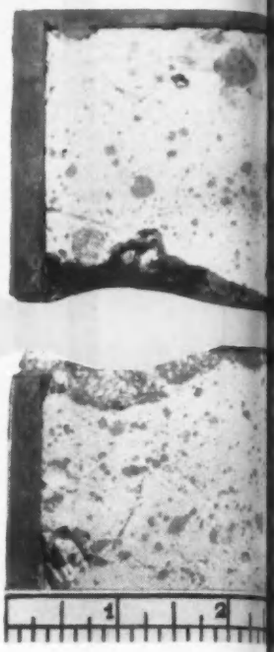

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This completely new perforator, the Welex Dyna-Jet, was designed and developed to meet all requirements for the ultimate in casing perforating.

This new concept of perforating has been designed and developed to give greater hole size, increased penetration, greater entrance hole area, greater hole volume, elimination of the slug or carrot, with a minimum of explosive in the charge.

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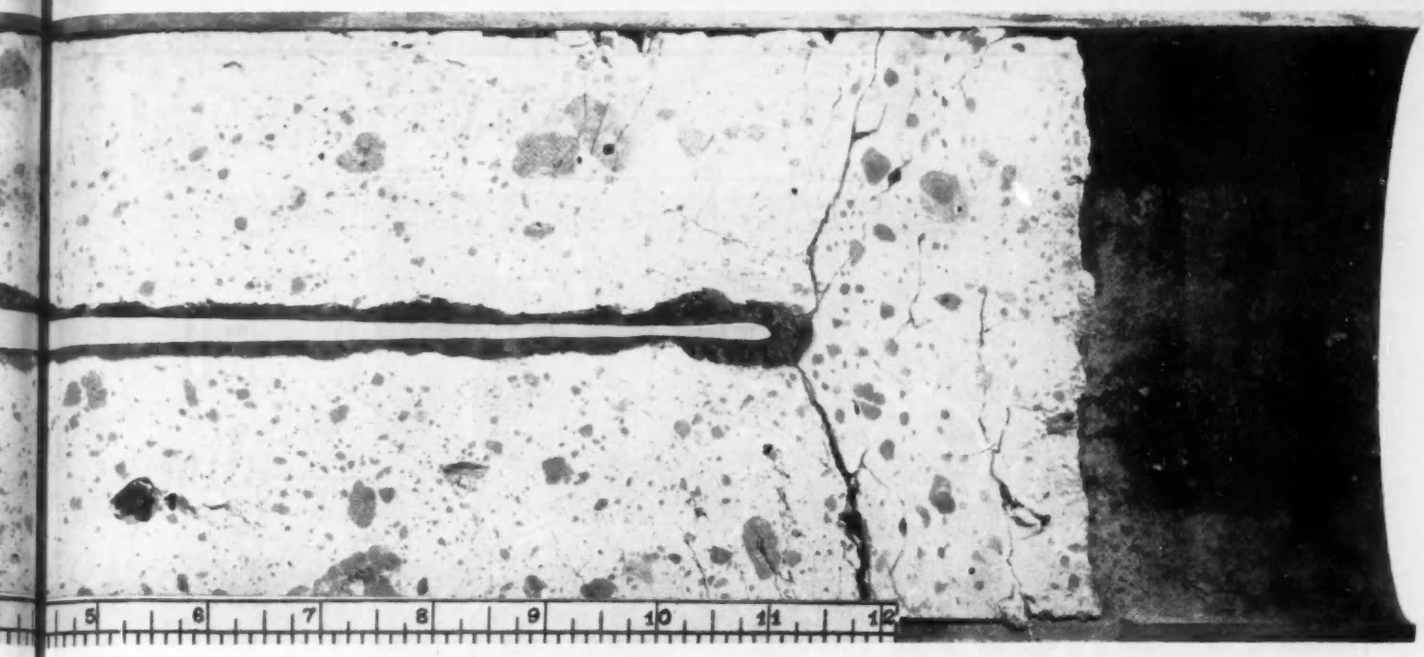

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And . . . **elimination of carrot or slug** is an added value which insures no plugging action in the perforation.

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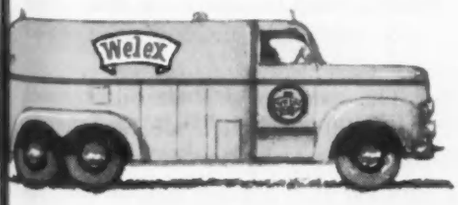

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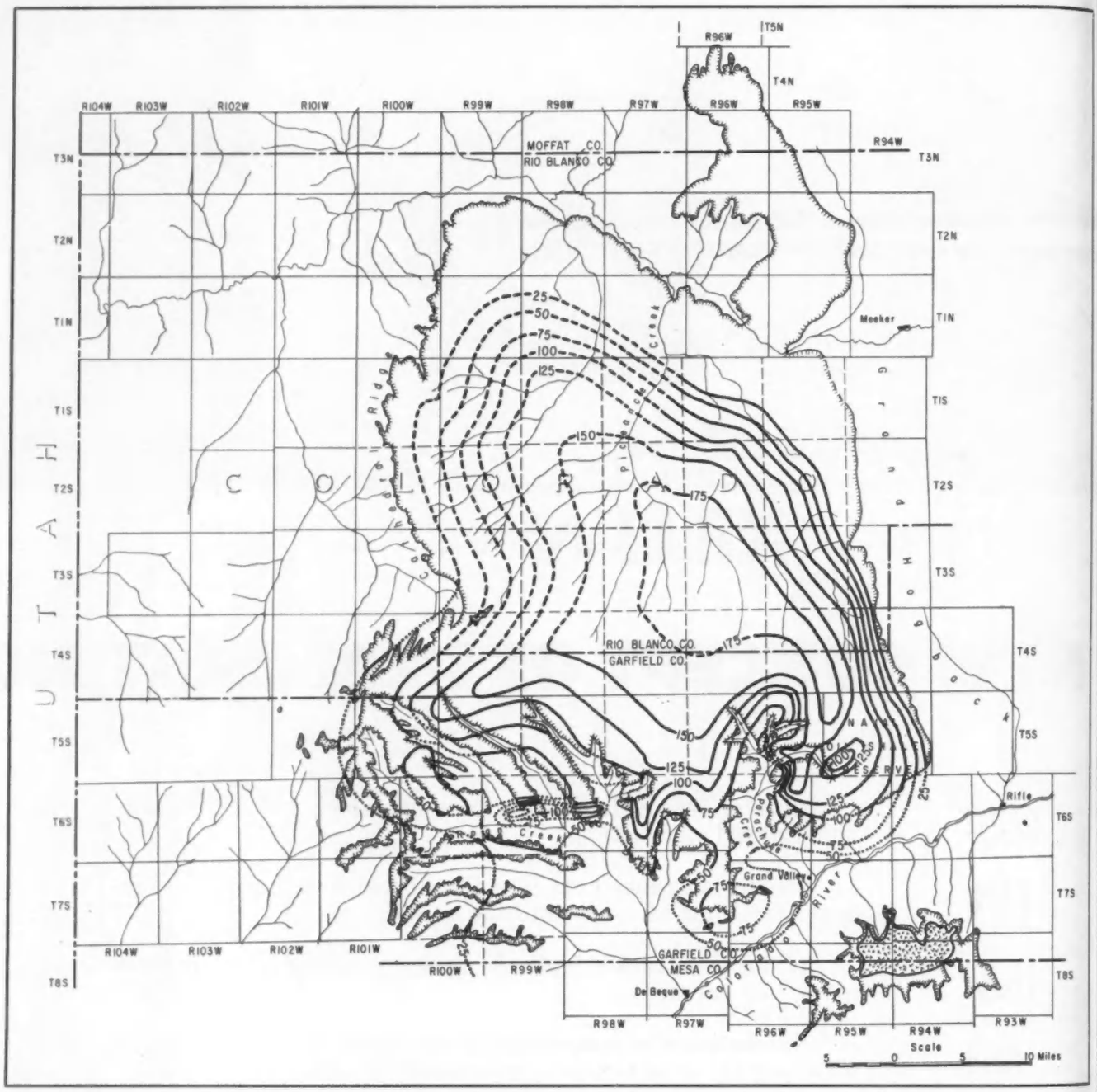

FIGURE 5—Oil shales of northwestern Colorado. The contours indicate total shale oil yield obtainable in millions of barrels per square mile from oil shales which yield 25 gallons or more of shale oil per ton.

introduce steam when the temperature reached about 900° F.

When heating oil shale in a retort, shale oil vapors begin to form at about 400° F. A temperature of 900° to 1100° F. appears to be ample to remove all of the shale oil.

It was determined at the Bureau of Mines Station in 1945 that 600 Btu's are required for complete distillation of one pound of oil shale broken into ⅛-inch to ½-inch fragments. Each pound of shale yields 1000 Btu on distillation, thus yielding an excess of 400 Btu.

The distillation of oil shale produces an oil that will yield gasoline, kerosine and lubricating oil without cracking.

Shale oil from sample No. 943, collected in Garfield County, Colorado, which produced 46 gallons of shale oil per ton, was fractionated with the following results:

Gasoline (to 150° F.)—16.5% water white
Kerosine (to 300° F.)—47.0% straw color to amber
Residue —36.5%

Some samples produced as much as 23.3 percent gasoline and 70 percent kerosine.

In addition to shale oil, other products obtained from retorting oil shale are flammable gas, ammonium sulphate, resins suitable for plastics, phenolic acids, high-melting point waxes and asphalt.

The quantity of shale oil obtained from different oil shale beds varies from a few gallons to 65 or more gallons per ton. For the purposes of this estimate all beds which yielded less than 25 gallons of shale oil per ton of shale have not been included.

Calculations of Shale Oil Re-

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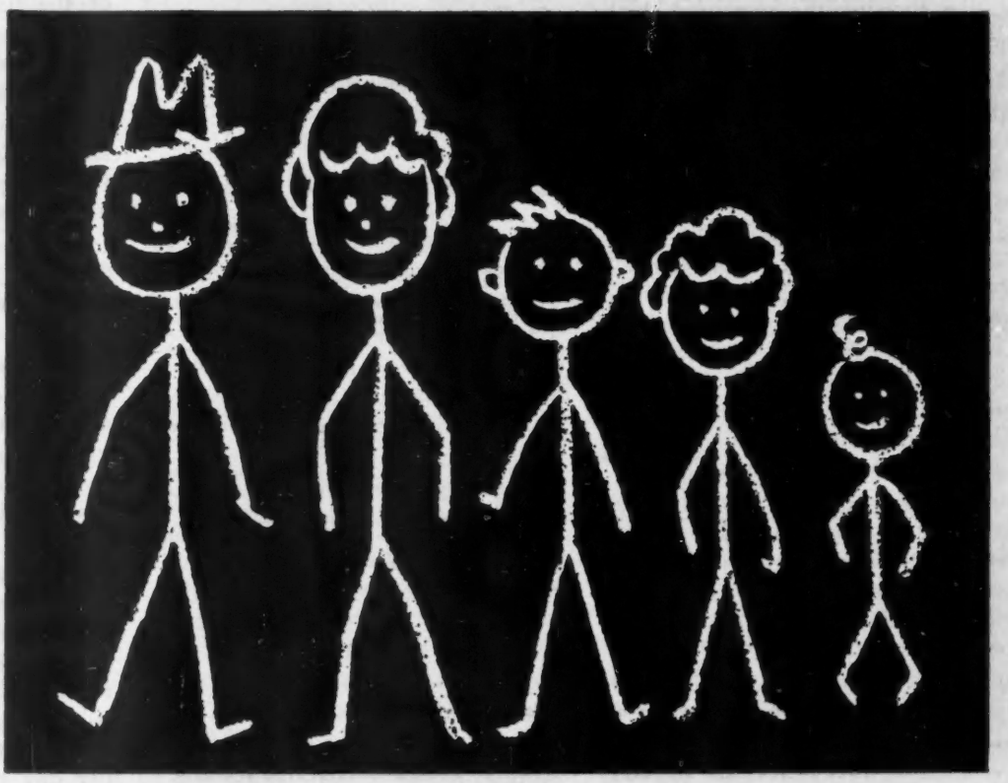

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serves. To evaluate the oil shale deposits a tabulation of the laboratory analyses was compiled by field stations for all samples collected at each station showing the measured thickness and shale oil yield of each bed. As an example, the tabulation for Field Station No. 45 is reproduced as Table 1.

Shale Oil Production from a Mine Covering One Acre. The visualizing of oil reserves by the thickness of shale beds and shale oil yields in terms of gallons per ton is somewhat foreign to the oil operator. Before being confronted with summary statistics let's examine one outcrop as an example to furnish a yardstick for realization of the importance of this potential oil supply.

Field Station No. 45 is located just west of Grand Valley, Colorado. The Rio Grande railway, Parachute creek and the Colorado River pass nearby furnishing a plant site, transportation and a water supply.

At this location there is a total of 30.8 feet of oil shale that will yield 25 gallons or more per ton. (See Table 1).

The uppermost beds total 10 feet in thickness and yield a weighted average of 28.5 gallons of oil per ton.

The shale oil reserves under one section of land at this location from the 10 feet of the upper two beds would be 11,774,720 barrels. Mining oil shale under present methods requires leaving one-fourth of the volume in place for supports, thus the recoverable reserves would be three-fourths of this amount or 8,831,040 barrels. A plant capable of mining and retorting 3000 tons of oil shale per day could produce 2000 barrels of oil per day for 12 years from one square mile of these two beds.

If the entire section of 30.8 feet (in eight beds) of oil shale which contains 25 or more gallons of oil were to be mined, the total reserves would be 34,853,280 barrels. At a production rate of 2000 barrels of oil per day this tract of one square mile would supply this plant for 47.7 years.

The recoverable reserves of 34,853,280 barrels represents 54,458 barrels per acre of recoverable oil from 30.8 feet of oil shale beds.

The increasing cost of discovering and producing petroleum is rapidly equalizing the cost of producing oil from oil shales with that of oil obtained from oil wells. In fact The Union Oil Company is now installing a commercial size retort near their five billion barrel recoverable oil shale reserve near Grand Valley, Colo. Some $5 million has been earmarked for an intensive research program to settle the question of the cost.[2]

Shale Oil Reserves in Garfield County. To evaluate the shale oil reserves in Garfield County the reserves present in each township were calculated by using a map for the

TABLE 1
Garfield County, Colorado, Field Location 45, 16-T7S-R96W

2.0 Gravity

Lab. No.	LESS THAN 25 GALLONS OIL PER TON: Thickness Feet	Oil/Ton Gallon	Oil/Acre Barrels	25 OR MORE GALLONS PER TON OF SHALE: Thickness Feet	Oil/Ton Gallons	Oil/Acre Barrels	Oil/Sq. Mile Barrels
819				7.0	28.0	12,675	8,112,000
820				3.0	29.5	5,723	3,662,720
821	4.0	22.0	5,691				
822	3.0	22.0	4,268				
823				2.0	38.5	4,980	3,187,200
824				3.0	25.0	4,850	3,104,000
825				1.0	45.0	2,910	1,862,400
826	2.5	22.0	3,557				
827				9.8	43.5	27,569	17,644,160
828				1.5	43.0	4,171	2,669,440
829				3.5	43.0	9,733	6,229,120
	9.5	....	....	30.8	....	72,611	46,471,040

$\frac{72,611}{30.8}$ = 2,358 Bbls. per average acre foot.

TABLE 2
Shale Oil Reserves of Garfield County, Colorado

Av. sp. gr. 2.0

		PART 1—MEASURED RESERVES						PART 2—INDICATED RESERVES			
1		2		3	4	5	6	7	8	9	10
Township		Acres	Sq. Mi.	Ft.	Acre Feet	Barrels/ Ton	Thousand Bbls.	Ft.	Acre Feet	Barrels/ Ton	Thousand Bbls.
4 S	99W	11,520	18.00	73.3	844,416	2,096	1,769,896	73.3	844,416	2,096	1,769,896
	98W	11,520	18.00	90.0	1,036,800	1,927	1,997,194	90.0	1,036,800	1,927	1,997,194
	97W	11,520	18.00	125.0	1,440,000	2,046	2,946,240	125.0	1,440,000	2,046	2,946,240
	96W	11,520	18.00	135.0	1,555,200	2,657	4,132,166	135.0	1,555,200	2,657	4,132,166
	95W	11,520	18.00	140.0	1,612,800	1,554	2,506,291	140.0	1,612,800	1,554	2,506,291
	94W	7,680	12.00	44.3	340,224	1,462	497,407	44.3	340,224	1,462	497,407
5 S	101W	2,624	4.10	22.0	57,728	2,625	151,536	22.0	57,728	2,625	151,536
	100W	15,168	23.70	26.4	400,435	2,574	1,030,720	40.0	606,720	2,574	1,561,697
	99W	16,767	26.20	36.5	611,996	2,337	1,430,165	60.0	1,006,020	2,337	2,351,069
	98W	17,740	27.72	40.6	720,244	2,149	1,548,019	85.0	1,507,900	2,149	3,240,477
	97W	22,414	35.02	45.6	1,022,078	2,281	2,331,360	125.0	2,801,750	2,281	6,390,792
	96W	18,991	29.67	35.0	664,685	2,963	1,969,462	135.0	2,563,785	2,963	7,596,495
	95W	15,273	23.86	110.0	1,695,303	1,733	2,937,960	115.0	1,756,395	1,733	3,043,833
	94W	21,284	33.26	68.7	1,462,211	1,630	2,383,404	100.0	2,128,400	1,630	3,469,292
6 S	94W	2,537	3.96	14.3	36,251	2,381	86,314	82.0	207,870	2,381	494,938
	95W	10,130	15.83	45.2	457,876	2,492	1,141,027	105.0	1,063,650	2,492	2,650,616
	96W	11,190	17.48	37.6	420,744	2,438	1,025,774	42.0	469,980	2,438	1,145,811
	97W	19,338	30.22	40.0	775,520	2,591	2,009,372	55.0	1,063,590	2,591	2,755,762
	98W	9,469	14.80	33.0	312,477	2,443	763,381	70.0	662,830	2,443	1,619,294
	99W	7,802	12.19	43.0	335,486	2,212	742,095	45.0	351,090	2,212	776,611
	100W	10,095	15.77	21.0	211,995	2,669	565,815	23.0	232,185	2,669	619,702
	101W	6,881	10.75	18.0	123,858	2,446	302,957	19.0	130,739	2,446	319,788
7 S	101W	2,398	3.75	9.9	23,740	2,781	66,021	12.0	28,776	2,781	80,026
	100W	6,481	10.13	5.4	34,997	2,152	75,314	25.0	162,025	2,152	348,678
	99W	5,213	8.15	19.5	101,654	2,629	267,248	22.0	114,686	2,629	301,509
	98W	3,336	5.21	29.2	97,411	2,254	219,564	35.0	116,760	2,254	263,177
	97W	9,261	14.47	32.9	304,687	1,973	601,147	55.0	509,355	1,973	1,004,957
	96W	2,085	3.26	32.8	68,388	2,473	169,124	42.0	87,570	2,473	216,561
	95W	1,755	2.74	4.7	8,249	1,929	15,912	30.0	52,650	1,929	101,562
	94W	2,537	3.96	4.7	11,924	1,929	23,001	17.0	43,129	1,929	83,196
8 S	95W	695	1.09	4.7	3,267	1,929	6,302	25.0	17,375	1,929	33,516
	99W	1,494	2.33	24.0	35,856	2,673	95,843	25.0	37,350	2,673	99,837
	100W	226	0.35	12.0	16,831,212	2,470	6,699	12.0	2,712	2,470	6,699
	....	308,464	481.97	....	.....	2,127Av.	35,814,730	....	16,831,212	2,127Av.	54,576,625

INDEX TO TABLE 2

This table furnishes the following information for Garfield County by township.

Column 1 Designates the township
" 2 The measured area within each township by acres and square miles underlain with oil shale. This area applies to both the measured and indicated reserves
" 3 The average measured thickness of oil shales within the township,
" 4 The number of measured acre-feet of oil shales within the township,
" 5 The average shale oil yield in barrels per ton for the township,
" 6 The measured shale oil reserves in the township expressed in thousand of barrels,
" 7 The indicated thickness of the oil shale deposits in each township,
" 8 The number of acre-feet of indicated oil shale deposits within the township,
" 9 The average shale oil yield in barrels per ton for the township,
" 10 The indicated shale oil reserves for the township expressed in thousands of barrels.
The totals, as shown, represent the values for Garfield County.

areal distribution and the field and laboratory data for the thickness and oil content.

The reserves are classified as measured and indicated (Table 2). This subdivision conforms to a nomenclature proposed by the Bureau of Mines and is repeated in an abbreviated form.

Measured Reserves: Those deposits or portions thereof supported by sufficient data to be considered proved.

Indicated Reserves: Those deposits lacking sufficient data to be mathematically proved, but which are supported by sufficient measurable data to be established with reasonable certainty.

Inferred Reserves: Those reserves which lack outcrops and analyses but which reasonably may be considered possible reserves from available knowledge.

In Garfield County there is sufficient sample control, to consider the indicated estimate reasonably representative. The total indicated shale oil reserve in the county is 54,577 million barrels. This quantity was obtained by using 2.0 as the average specific gravity of oil shale.

The Bureau of Mines personnel used 2.23 for the specific gravity of oil shale in making their calculations. This is the average specific gravity of oil shale which yields 25 gallons of oil per ton. The 54,577 million barrel estimate for Garfield County was converted to a 2.23 gravity basis so that it will coordinate with Belser's data. This conversion raises the value from 54,577 to 60,826 million barrels.

Rio Blanco County, Colorado. Oil shale beds in Colorado extend to the north of Garfield County into Rio Blanco County as shown on Figure 2. (See Page 199, WORLD OIL, December, 1956.) In this county there is much less erosion and consequently fewer outcrops of oil shale. However, the outer limits of the Green River basin are exposed in enough localities to define its limit. The Empire parties examined these boundaries and sampled the oil shale along the outcrops.

Recently a number of oil wells and some core drill holes have been drilled through the oil shale beds within the interior of the basin. These samples have been described by Carl Belser.[3]

Belser's data is summarized in Table 3 which tabulates the location, notes whether it is an oil well, core drill hole or surface sample and indicates the shale oil content per square mile at each location. These locations have been placed on Figure 2 and bear the same number as is shown in column 1 of Table 3 for identification.

By assembling the data from Table 3 with the analyses of outcrop samples made earlier on a composite map which includes both Rio Blanco and Garfield counties, it is possible to estimate the shale oil reserves for Rio Blanco County.

Two maps were prepared for this purpose. First, Figure 4 which is an isopach map, shows the total thickness of all the oil shale beds in the two counties which yield 25 gallons of shale oil or more per ton of shale.

The second is Figure 5 which is an isometric contour map covering Garfield and Rio Blanco counties. The contour lines on the map represent the shale oil reserves in place in terms of millions of barrels per square mile. These reserves are obtainable from the total thickness of all shale beds present below each contour which yield 25 gallons or more of shale oil per ton.

In Rio Blanco County there is less

TABLE 3

Core Drill, Oil Well and Surface Oil Shale Samples from Rio Blanco County taken since the Empire Survey was made and which were used in the preparation of Figures 4 and 5.

Number	COMPANY	Name or Designation	Type Sample	LOCATION				Shale Oil Yield Per Sq. Mile, Million Bbls.
					Sec.	Twp.	Rge.	
1	General Petroleum Co.	GP-28-19-G	Rot. Cut.	SE-SW-SW	19	2 S	95W	103.7
2	General Petroleum Co.	GP-66-5-G	Rot. Cut.	SE-NW-SE	5	2 S	96W	115.9
3	General Petroleum Co.	GP-24-12-G	Rot. Cut.	SE-SW-NW	12	2 S	96W	80.6
4	General Petroleum Co.	GP-84-15-G	Rot. Cut.	SE-SE-NE	15	2 S	96W	163.8
5	Bureau of Mines	Hole G	C D	NW-SW-NE	3	5 S	94W	11.5
6	Bureau of Mines	Hole F.	C D	NE-SE-SE	6	5 S	94W	129.0
7	Bureau of Mines	Hole I	C D	NW-SE-NW	20	5 S	94W	138.7
8	Bureau of Mines	Hole L	C D	NE-SW-NW	22	5 S	94W	98.0
9	Bureau of Mines	Hole J	C D	SW-NW-NW	24	5 S	94W	22.0
10	Bureau of Mines	Hole E	C D	SW-SW-NW	2	5 S	95W	180.5
11	Bureau of Mines	Hole D	C D	SW-SW	11	5 S	95W	179.0
12	Columbia Oil Shale Co.	Columbia	Surf	.....	15 & 16	5 S	95W	162.3
13	Union of California	Bella Castle	C D	NW-NW-SE	19	5 S	95W	149.3
14	Union of California	Lindaur Point	Surf.	E/2	19	5 S	95W	111.7
15	Union of California	Lignum Vita #9	C D	NE-NW-SE	20	5 S	95W	129.6
16	Union of California	Lignum Vita #13	C D	SE-SW-NE	21	5 S	95W	158.0
17	Bureau of Mines	Hole H	C D	SE-SE-NW	23	5 S	95W	151.9
18	Sun Oil Co.	Summer's Camp	C D	NE-NE-SE	2	5 S	97W	151.3
19	Sun Oil Co.	Magers Camp	C D	SW-NW-NW	20	5 S	97W	123.0
20	Sun Oil Co.	Bear Run	C D	NW-NW	25	5 S	97W	146.4
21	Federal Oil Shale	Cottonwood	Surf.	NW-SW	9	5 S	98W	93.6
22	Standard of California	Syndicate No. 2	C D	SE-SW-SW	9	5 S	98W	97.3
23	Standard of California	Syndicate No. 1	C D	SE-SW-NW	11	5 S	99W	87.9
24	W. W. Felts	Long Point	Surf.	.....	7	7 S	97W	50.3
25	W. W. Felts	Carr Creek	Surf.	NE/4	29	5 S	99W	48.5
26	W. W. Felts	Wallace Creek	Surf.	NW/4	9	8 S	95W	47.4
27	Bureau of Mines	Hole K	C D	SW-SW-SW	5	6 S	95W	137.4
28	Bureau of Mines	Hole B	C D	SE-NW	12	6 S	95W	96.0
29	Bureau of Mines	Hole C	C D	SW-NW	12	6 S	95W	104.6
30	Bureau of Mines	Hole A	C D	NE/4	12	6 S	95W	98.6
31	Bureau of Mines	Allen Point	Surf.	NW-NW	30	6 S	95W	93.7
32	Bureau of Mines	Cottonwood	Surf.	NW-SE	22	6 S	95W	83.0
33	Union of California	J. B. M. No. 6	C D	NW-SE-NW	10	6 S	96W	152.6
34	Standard of California	Akolt No. 2	C D	SW-SE-NE	7	6 S	97W	105.6
35	Pure Oil Co.	Conn Creek	Surf.	NE-SW-NE	17	6 S	97W	57.3
36	Federal Oil Shale	Newton Point	Surf.	SE-SW-SW	3	6 S	98W	84.1
37	Standard of California	Akolt No. 1	C D	NE-NW-SW	14	6 S	98W	104.5
38	Standard of California	Scott Fee No. 1	C D	NE-SE-NE	17	6 S	98W	102.4
39	Standard of California	Akolt No. 3	C D	SW-SW	24	6 S	98W	102.0
40	Pure Oil Co.	Batt. Mesa	C D	SW-NW	36	7 S	94W	10.3
41	Federal Oil Shale	Echo No. 3	Surf.	SW-SW-SE	21	7 S	97W	72.3

Index to Abbreviations: Surf.—Surface sample. C D—Core Drill. Rot. Cut.—Rotary Cuttings.

FIGURE 6—Splinters of rich oil shale can be ignited easily with a match.

About the Author

EARL A. TRAGER is chief geologist for H. Zinder & Associates, Inc. In his employment he has done extensive work in the oil and gas field and other businesses. After graduating with a B.A. in geology from the University of Chicago, he worked as a geologist with Empire Gas & Fuel Company from 1917 to 1920. His background experience includes chief geologist in Mexico and chief of the Geological Research Department of the Marland Oil Company, chief geologist Skelly Oil Company covering the Mid-Continent, Texas and Rocky Mountain areas, vice president of Bell & Howell, geologist with the Critical Minerals Program, geologist for Sinclair Oil Company and senior geologist for the Federal Power Commission.

data upon which to base a firm estimate. The reserves for that portion to the east which is contoured with solid lines are classified as indicated reserves. Those for the remainder of the area are considered to be inferred and the contour lines in that area are dashed.

The total shale oil reserves in place were calculated by planimetering Figure 5. By this method the following data was determined for Rio Blanco County.

The **indicated reserves** underlie 186 square miles and are estimated to contain 22,786 billion barrels of shale oil.

The **inferred reserves** (the area containing dashed lines) underlie 440 square miles and are estimated to contain 49.491 million barrels of shale oil. (Five percent was deducted for stream erosion from the Rio Blanco estimates since no large scale maps were available for accurate determination.)

The reserves for Garfield County were also calculated by planimetering Figure 5. The result by this method was essentially the same as that shown in Table 2. Determined by adding the values calculated in each township.

Total Shale Oil Reserves of the Green River Basin in Colorado. The total shale oil reserves for Colorado are obtained by combining the estimates for Garfield and Rio Blanco counties. The area of Figure 5 which is contoured is thought to represent the total area which contains commercial deposits, i.e., those yielding a minimum of 25 gallons of shale oil per ton of shale.

The total reserves for Colorado by type, area of each type and volume are shown in Table 4.

The total recoverable shale oil reserves for Colorado estimated from this study is 99.828 billion barrels.

If improved technology or price makes it possible to use the shales which yield but 15 gallons of shale oil per ton, the indicated reserves will be more than doubled.

Across the border in Utah there are additional oil shale deposits similar in quality to the Colorado shales. Although these deposits are extensive the shale oil reserves which they contain are less than those in Colorado.

REFERENCES

[2] Gilbert M. Wilson, "What Union Oil of California Is Doing About Shale Oil," WORLD OIL, September, 1956, p. 86.

[3] Carl Belser, Green River Oil-Shale Reserves of Northwestern Colorado, Bureau of Mines, Report of Investigation, Vol. 4769.

TABLE 4

COUNTY	Classification of Deposits	Area Underlain by Oil Shale Square Mile	Gross Shale Oil Reserves Billion Barrels	Recoverable Reserves Billion Barrels
Garfield	Indicated	482	60.826	45.620
Rio Blanco	Indicated	186	22.786	17.090
	Inferred	440	49.491	37.118
TOTAL	For Colorado	1108	133.103	99.828

Stop Corrosion

Continued from Page 174

period of from two to three hours, depending upon the amount of fluid the well made. Coupon tests showed that the inhibitor was giving much better than normal protection.

Upon investigation, it was discovered that in many cases the wells were not being circulated for the full length of time considered advisable. It then became apparent that the superior results obtained by using this inhibitor were due to the fact that it acted effectively without being circulated.

In December, 1955, tests using radioactive iodine were conducted to determine how rapidly the new inhibitor fell through the well fluid and was produced out through the well head.[1] It was found that it fell through oil at the rate of about 20 feet per minute, and was produced back to the surface in about two and one half hours. An oil soluble inhibitor which was tested the same way remained in the well for six days before it was produced at the well head. These results definitely indicated that the new application method was working in the manner expected.

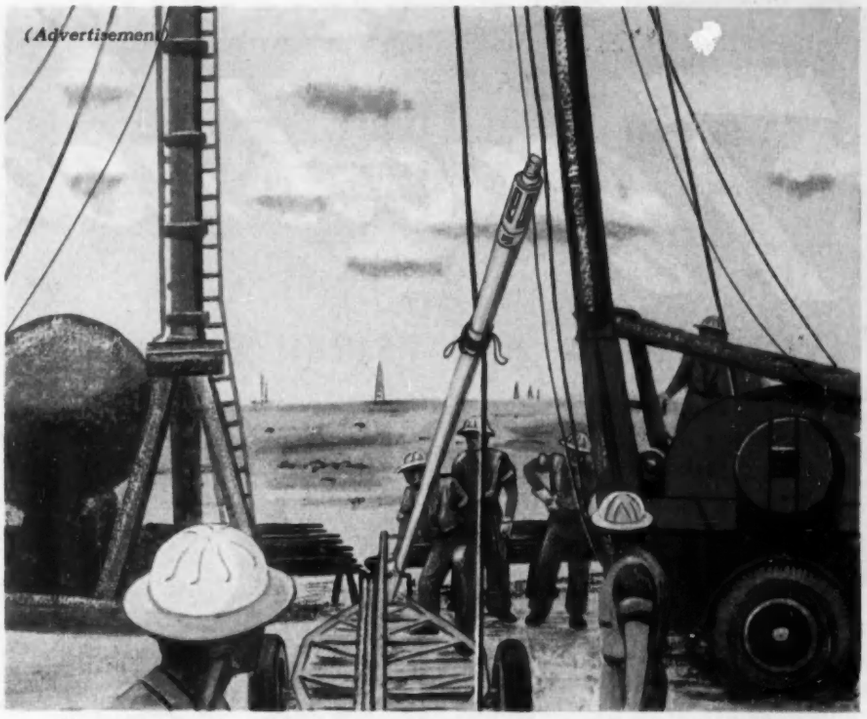
This treating technique is now being used on wells in practically all the major corrosive areas of Kansas. In several areas it has been used for as long as two years. Results, in terms of coupon tests and the replacement of well parts, show that it is giving effective protection. A total of about 140 Kansas wells are now being treated by this new method.

A typical example of results obtained can be seen in the records on a four-well lease in Ellis County, Kansas. The operator treats each well twice weekly, injecting inhibitor in the proportion of about one quart of inhibitor for each 150 barrels of well fluid. The wells are pumped 24 hours a day. According to the lease operator, excellent protection is being given and less time is now required for the treatments. In addition, the lease now produces, because of the increased pumping time now possible, 11 more barrels of oil per week than it did when the conventional corrosion treatment method was used.

REFERENCE

[1] Koger, W. C., "How to Get the Most from Your Inhibitor," World Oil, Vol. 142, No. 4, Mar., 1956, p. 167.

(Advertisement)



Upper section of world's longest sub-surface rod pump is raised by pulling machine. Two units were made up at stuffing box, then lowered into well and seated as a single pump.

80′ – Longest Ever Run

H-F "Double-Displacement" Rod Pump Increases Oil 130 B/D

An 80-ft. Harbison-Fischer Double-Displacement® Rod Pump — the longest sub-surface pump ever built — is successfully operating in West Texas and has increased production a whopping 130 Bbl./day. Operator ran the Double-Displacement® Rod Pump rather than pull the production string and install a tubing pump to handle the necessary fluid volume to make the allowable. Although the Double-Displacement® is a regular insert-type pump run on rods, the unit will handle more fluid than a comparable-sized tubing pump.

The Double-Displacement® pump is now making approximately 775 Bbl. of fluid per day on a 26-ft. stroke hydraulic jack. The well is a dual-completion, the Devonian flowing through the casing and the Ellenburger pumping through 2½-in. tubing from perforations below 10,000 ft.

The previous pump was a 2½"x1¾"x 40′ rod pump which only made 90 Bbl. of oil to 290 Bbl. of water on 5 26-ft. S/M. The 2½"x2"x2"x80′ Double-Displacement® Rod Pump increased the oil production to 220 Bbl. of oil and 555 Bbl. of water on 4½ 26′ S/M. Owing to the length of the pump, the assembly was raised in two sections, made up in the well, and then run to bottom as a single unit. The pump was set at 6,000 ft., using a conventional cup-type bottom hold-down.

Other than the unusual length, the pump was of a standard Double-Displacement® design, the same as regularly available through leading supply stores in all major producing areas.

The Double-Displacement® pump is an insert-type, traveling barrel, bottom hold-down assembly made up of two plungers and two barrel tubes which work simultaneously with a single set of valves. In operation, the assembly produces as two separate pumps made up in tandem which virtually doubles the volume of the unit as compared to the displacement of comparable-sized conventional pumps.

The producing situation of the West Texas well was one of two identical conditions for which the Double-Displacement® pump is recommended by the manufacturer: To move more gross fluid, or the same fluid volume at slower pumping rates. In either case, the Double-Displacement® Rod Pump will produce the desired amount of fluid without the operator's having to install a larger bore pump.

The only successful tandem rod pump ever designed, the Double-Displacement® pump was patented by Harbison-Fischer and has been on the market several years. Hundreds are in daily operation in fields throughout the Mid-Continent and Gulf Coast areas.

The pump is available in a wide range of metal-to-metal, H-F "Flexite"®, or soft packing plungers with chrome-plated or heat-treated barrel tubes in 2"x1½", 2½"x2", 3"x2½", and 4"x3¼" sizes. Illustrated literature and comparison data are available without obligation from Harbison-Fischer Mfg. Co., P. O. Box 127, Fort Worth, Texas, or from any of the firm's factory representatives throughout the oil patch.

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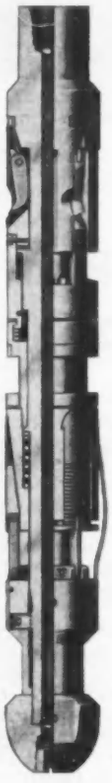

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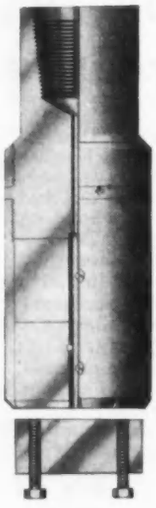

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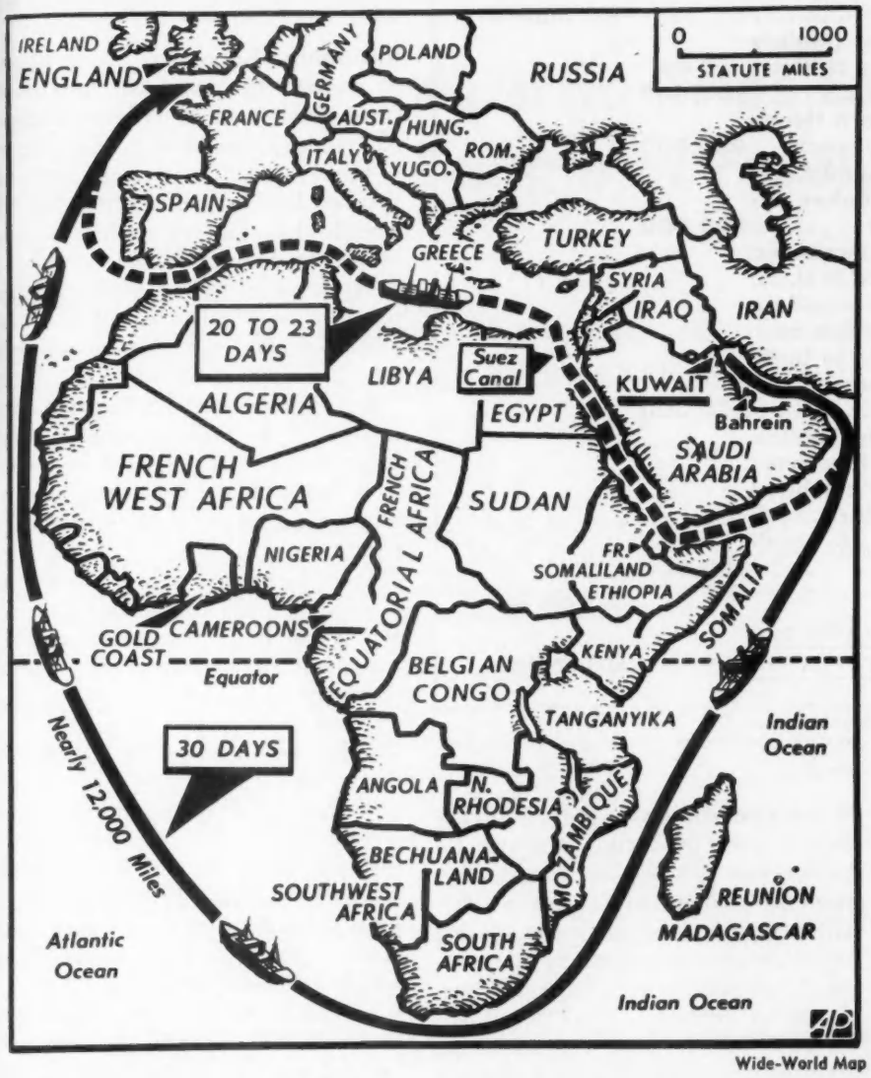


Wide-World Map

The solid black line indicates the route of a tanker which reached England with the first Middle East oil since the Suez Canal was blocked. The shipment took 30 days to move the approximately 12,000-mile route around the Cape of Good Hope. The dotted line shows the 20-30-day route through the canal.

As result of Suez blocking . . .

Will Western Europeans Reappraise Value of Oil?

How much benefit will Soviet Russia gain from the trouble in the Middle East?

By DON KLIEWER
World Oil Staff

While the U. S. was moving in to plug a gap in Western Europe's winter oil supplies, dangerously cut down by the Suez canal controversy, another possible serious result of the Mediterranean crisis emerged. In recent years, Western Europe has been turning more and more to oil in heating its homes and fueling its industries.

Now, made mindful of the precarious oil supply line, will Western Europe consider turning again to a more certain coal supply at the expense of a continuing growth in oil use? The Free World's efforts to make up the difference resulting from loss of Middle East crude likely will prevent this industry-wide reversal.

However, while the oil industry was pondering over such questions as supply and transportation and while the U. S. government was studying the economic facets of supplying oil and furnishing money to Western Europe, the military had its own problem to consider: how much benefit is the Middle East crisis to Russia?

The Soviets have seen that the closing of a canal can send the major Western European powers reeling and can disrupt the Free World's oil supply. And the U. S., No. 1 obstacle to Russian hopes of world conquest, can be forced to speed to Western Europe's behalf with much oil and money.

The Free World has every reason to be chary of its economic and military position come spring. What would happen in Europe if Western Europe, after a cold winter, found its supplies of oil low enough to cause outright military uneasiness and civilian unhappiness? If Western Europe's air forces, armies, naval fleets, and transportation systems were immobilized to any serious degree because of lack of sufficient fuel, dangers could mount.

Too, financial pressures lie ahead for Western Europe. England, for example, faces a serious drain on its never-satisfactory dollar supply.

Also, if it is forced to ante up sterling or gold as collateral for World Bank loans to buy oil, its financial position would be further weakened.

How critical these dangers could be is emphasized by the proximity of Soviet troops, dispatched to the satellite countries to prevent or stop rebellion. If these Red troops spend the winter in large numbers near the

Western Europe Oil Scoreboard

	BARRELS PER DAY
Requirements: About 2.7 million barrels a day which might be cut through rationing to about	**2.3 million**
Supplies: Domestic production (mainly in Germany, Austria and The Netherlands)	**200,000**
Normal imports from Western Hemisphere, mainly from Venezuela	**400,000**
Expected to be brought around Cape of Good Hope by time tanker rerouting becomes effective	**800,000**
Expected to be feasible by increased production of 800,000 bpd in U. S., of which 500,000 barrels would be exported to Western Europe and 300,000 barrels would go to U. S. East Coast to replace normal imports from Middle East	**500,000**
From Saudi Arabia, assuming Tapline remains in operation. However, Britain and France would not have access to this supply since both are barred from access to Saudi Arabian crude	**300,000**
	2.2 million
Apparent net deficit in Western Europe this winter *after* rationing	**0.1 million**

border of Western Europe training and equipping themselves, the possibilities—come spring—become unpleasant.

As unpredictable as it is vehement, the Soviet Union would be in a position where it could have crushing power held in readiness at the border. An attack westward might be expected to erase dissension within the Soviet Union and to force a coalition among the satellites.

Russia has offered to supply at least one Western European country—France—with oil. But that available supply is limited. Theoretically, the USSR could supply from 100,000 barrels to 150,000 barrels a day to Western Europe, for that is the approximate extent of its surplus.

However, Russia has a small tanker fleet which would have to be deployed from Black Sea ports. Russia's oil setup is geared to satellite facilities; any rearrangement would be extremely complicated. Even attempting to move the oil by rail would be difficult since Russia does not have an abundance of rail tank cars. Too, Russia and Rumania were sending 15,000 barrels of oil daily from the Black Sea to Russia's Pacific Coast, via the Suez canal. Russia likewise will feel a strain on its transportation system now that the canal is blocked to traffic.

Venezuelan Assistance. Venezuela's crude production is almost 2.5 million barrels daily, up considerably from 2.1 million barrels a day in 1955. However, all companies operating there are operating virtually at capacity. Transportation facilities are burdened to capacity. There is no immediate way to raise the producing level significiantly. The new Barinas pipe line to Puerto Cabello has been stepped up for completion in July, but that will not help Western Europe this winter.

Production Increases. European domestic oil production is being increased as much as possible. But indigenous production generally is slight compared to needs, and it cannot be increased significantly.

Current French domestic requirement is approximately 400,000 barrels daily. Current production is 30,000 barrels a day.

In England, domestic needs range up to about 620,000 barrels of oil a day. Current output is 1100 barrels daily. And there is no immediate hope in the exploration program to change this situation.

And east of Suez, the dislocation of oil supplies from the Middle East has caused Israel to boost its domestic oil output and its drilling operations in its one successful oil field to produce 2100 barrels to 2800 barrels of oil daily by February.

Rationing. Rationing to one degree or another has been put into effect throughout much of Western Europe. And at least one Middle East country—Turkey—has invoked gasoline rationing. Turkey, a U. S. friend in the Middle East, is geographically situated next door to Iraq.

While no rationing action has apparently been taken in Austria and West Germany, it is general throughout Scandinavia.

In 1955 Austrian daily production amounted to 68,179 barrels (Page 256, World Oil International Outlook Issue, August, 1956), and no signs of an oil shortage were yet apparent in Austria.

West Germany, whose crude production in 1955 amounted to a daily average of 61,220 barrels, is producing about 30 percent of its domestic requirements and likely will be less affected than other nations.

Other repercussions of the Middle East crisis are:

- That in a relatively short time, some of the oil-rich Middle East powers will begin to feel the pinch of lessened income. Importance of oil sales is emphasized by the very character of the countries' economies, which are based largely on oil.
- That U. S. shipyards, which were about the only ones in the world not booked up for tanker construction, are getting orders fast. Because of the tanker boom, steel plate is in tight supply—and will get tighter.
- That the U. S. is continuing to face a dilemma in Egypt. The Suez canal, of course, is blocked and the situation is not optimistic concerning a quick settlement and clearing of the canal. The U. S. has not expressed too much concern over the fact that Nasser "nationalized" the Suez Canal Company a short time after reaffirming its franchise on the canal until 1968.

The U. S. favors international control of a sort, but since the U. S. is renewing economic and technical aid to Egypt, it does not appear as if this country were trying to push Nasser.

The difficulty is clear: if the U. S. does not help Nasser, Russia will. And that would be worse.

—**The End**

Austria Tries to Unravel Tangle of Foreign Control

Here is a summary of the past, present and future plans based on an evaluation of the nation's oil and gas fields as well as political and economic pressures.

WHEN THE SOVIET UNION physically and legally handed over the Austrian oil business to the Republic of Austria in 1955, a long period of foreign influence ended on this branch of industry. The German Reich won the majority of stock and concession from March 13, 1938, on, while the Soviets took over the oil industry in August, 1945, as a confiscated German Foreign Asset.

When Austria's national economy lost the control of its oil industry in 1938, crude output stood at 223,040 barrels (1937); when it got the industry back, production had soared to 24,885,568 barrels (1955). The profits, however, went to the Germans (1938 to 1944) and to the Soviet's state (from 1945 to the middle of 1955).

Active at the beginning of 1938 were the following companies:

- RAG: At Gaiselberg (1938 production: 1265 barrels). At Zistersdorf's RAG-Dome (1937 production: 54,200 barrels).
- EPG: At Zistersdorf's Goesting-Dome (1937 production: 154,318 barrels).
- Raky-Daubia: At Zistersdorf's RAG-Dome (1937 production: 1710 barrels).
- Steinberg-Naphtha: At Neusiedel (1937 production: 12,738 barrels).

RAG (Rohoel Gewinnungs Gesellschaft), founded jointly by Shell Oil and Vacuum Oil Company in 1932 had about 7000 "claims" registered at the beginning of 1938. It worked on a small portion of this territory that covered what is now (in 1956) known to be the richest oil-bearing area. EPG (Erdoel Produktions Gesellschaft) was founded by Vienna Banker Brunnbauer with Swiss capital in 1929. It was the most productive company.

Raky-Daubia was owned by German industrialist Dr. Anton Raky. It had a German majority, financially, even before 1938.

Steinberg-Naphtha was founded as the first really operating foreign company by Polish industrialist Thomas von Laszcz, with French capital, in 1926.

Aside from the producing companies, the R. K. Van Sickle, a Canadian-financed drilling company, was operating (first well brought in dry at Neusiedel during 1937) and also the Europasco (Austrogasco) Company that operated a small gas field near Oberlaa, south of the Danube river.

"From the time the first oil was discovered in Austria by accident, in the early 1900's hardly any international interest in Austrian oil was evident," said Dr. Karl Friedl, one of the five oil pioneers of Austria. The first company to engage funds was Vacuum Oil Company, which had the Vienna basin geologically mapped by Dr. Friedl during 1925-1926. Then it pulled out.

Ardent supporter of private enterprise, the conservative Peoples' Party won a surprise victory in the May 13, 1956, Austrian "oil election." Its platform, with the nation's petroleum industry as the primary political issue, had been attacked vigorously by the Socialists, who had campaigned for nationalization.

Tabulation of the votes gave the Peoples' Party 82 seats in the Lower House of Parliament; the Socialist Party (for outright nationalization), 75 seats; the nationalistic Freedom Party, 5 seats; and the Communist Party, 3 seats.

THE PEOPLE'S PARTY PLATFORM

- Outright and total nationalization of the oil industry must be avoided.
- Western oil companies should have their properties returned, as agreed upon in the Vienna Memorandum.
- All crude production, refining and marketing companies should be united in a stock company of which the Austrian government—through the Ministry of Finance or Ministry of Nationalized Industry—should control 51 percent. The remainder should be divided between Niogas Company, a public enterprise in Lower Austria, and shares sold to individuals, instead of banking institutions.
- The price of milk, below the index level of other food costs, should be subsidized by a small additional fee on oil products sales.

The small Austrian oil capital was more interested in the Galician oil field where Austrian oil interests had remained from the time this Polish area was part of the Austro-Hungarian empire. Some Swiss, French and German private capital—and later, Canadian capital—flowed into Austria.

"It was too slow and too small," Dr. Friedl said, "to really provide for the entirely possible fast development of the known resources."

Again, it was the Vacuum Oil Company that founded, jointly with Shell Oil, the now most prosperous Austrian oil company, Roehoel Gewinnungs Gesellschaft.

German Annexation a Change. Austrian exploration and producing companies worked on the legal basis of the Oesterreichisches Berggesetz. This Austrian mining act distinguished between "claims" and "concessions." When Austria became part of the German Reich on March 13, 1938, a switch toward the German oil law, the Bitumengesetz was decreed Aug. 3, 1938.

This Bitumen Act did away with "claims." It offered the claim-holding enterprises a transfer into concessions if the company could prove exploration or development activities in the claims area. Otherwise, the claims would be taken away—after reimbursement for all investments—and allocated to another company willing to engage in drilling activities.

RAG fell victim to this change since it had more than 7000 claims registered at the time, but could not work on the entire area. The German Reich had issued a decree whereby a two-year period would be given (until July 31, 1940) to permit companies to spread exploration drilling over larger areas.

Unable to do so, RAG lost most of its claims after Aug. 1, 1940, but was reimbursed by the German state for all investments in the former claims area. (Well-informed Viennese sources estimate the reimbursement at about $1,430,000).

Since the switch from the Austrian to the German mining laws did not contain any power for force, no actual changes in ownership can be traced to this law.

Here, For The First Time, Is A Detailed Evaluation of Austrian Oil Fields

Field	Producing Depth (Feet)	Number of Producing Wells	Average Production Per Well Per Day (Barrels)	Status
Muehlberg	3396-5576	94	63	Drilled up, but deeper drilling tests planned.
Alt-Lichtenwarth	....	1	12	Will soon be depleted.
Plattwald	....	8	11	Declining.
Van Sickle	1600-5248	33	14	Declining.
St. Ulrich	2952-3936	153	12	Drilled up. Rapidly declining.
Neusiedel	3936-4264	4	...	Declining.
Goesting	....	41	18	6% oil, 94% salt water.
RAG Dome	2952-3936	17	17	Declining.
Windisch-Baumgarten	*(First successful well produced a total of 4000 barrels)*			Depleted.
Gaiselberg	4921-6560	53	18	Peak reached in 1942.
Maustrenk*				
1. Kreuzfeld-Pioneer	Less than 3280	3	7	Peak reached in 1944.
2. Maustrenk	"	15	7	Peak reached in 1944.
Scharfeneck	3608	...	...	Peak reached in 1944; no current production.
Hohenruppersdorf	....	1	12	Peak reached during 1944 and 1947.
Rabensburg	4560	4	...	Discovered in 1955. Field in exploration phase. No evaluation possible yet.
Matzen	5200-5500	332	156	Field in development stage; several hundred more wells scheduled to be drilled.
Aderklaa	5576-5904	34	68	Drilled up. Peak reached in 1953, but declining.
Suessenbrunn	6560-7870	3	...	No production currently.

** Field actually divided into two producing areas as listed.*

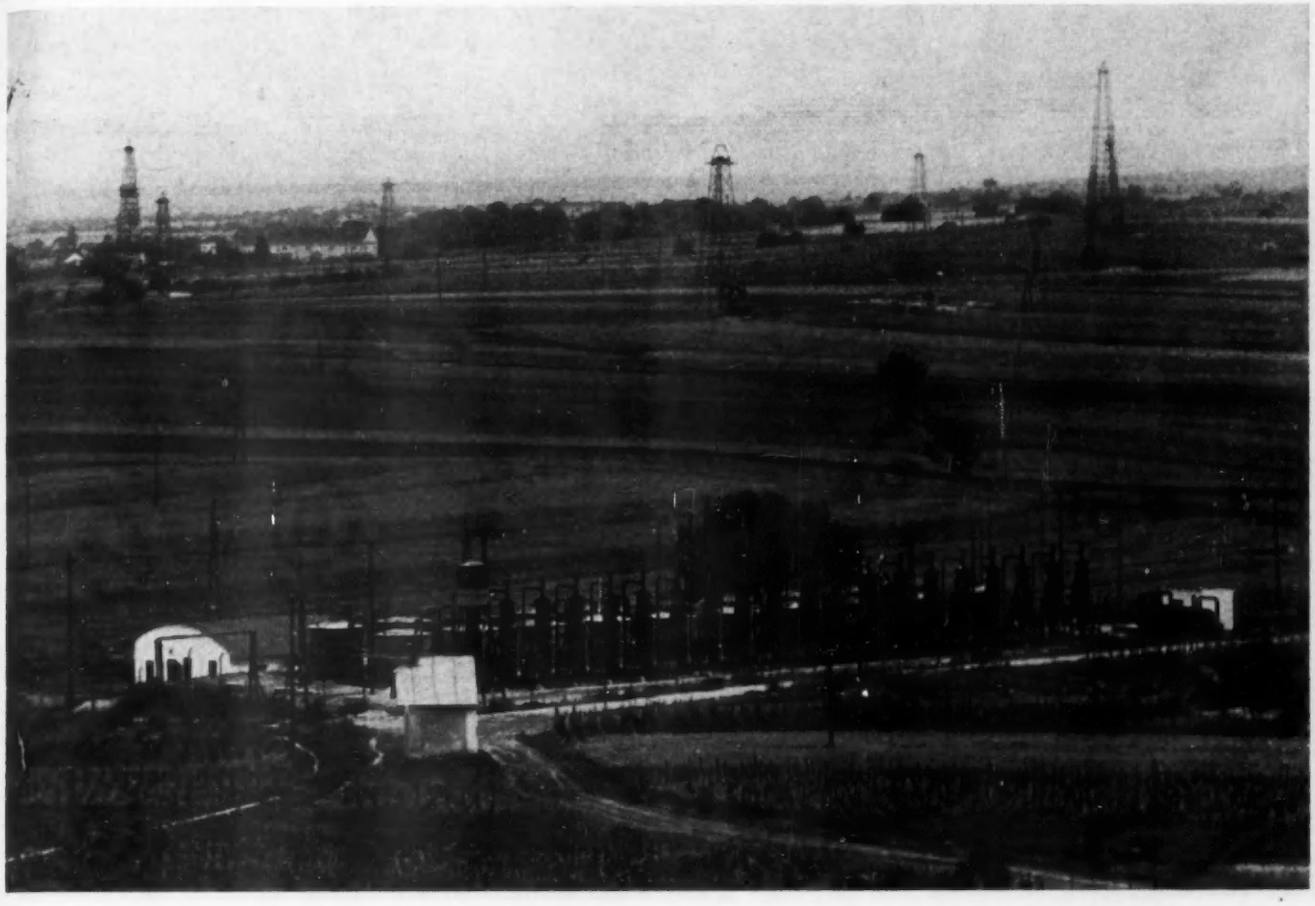


FIGURE 1—This is part of the Matzen-Auersthal producing area. The Auersthal separator battery is in the foreground.

Pressure and force entered simultaneously, however.

Before the deadline for the end of "claims" drew near, German oil companies persuaded several Austrian-licensed firms to sell titles to their claims to them. The persuasion, as it is described in Vienna today, was more or less high-pressured.

The R. K. Van Sickle firm sold a considerable part of its claims, allegedly to compensate for losses that occurred when Van Sickle Well 1 proved dry. Part of the sales funds were used to drill Well 2, a successful project opening up the Van Sickle Dome (May, 1939).

During September, 1938, Deutsche Erdöl A. G. (which had bought Van Sickle claims) developed the St. Ulrich field, which became one of East Austria's richest producing areas.

Steinberg Naphtha sold a large number of claims to the German Itag which, soon after the 1940 sale, developed the Muehlberg field (1942). RAG was unwilling to sell claims to the German firms, but participated in the Roehoel Gewinnungs A. G., Elwerath, and Preussag Syndicate which planned to work on RAG claims south of the Danube river.

Germans Gain Control. Austrian pre-war registration of all claims became invalid as of Aug. 1, 1940. No agreement could be reached between the competing German oil firms as to the distribution of the free areas. As a compromise, a new company was formed, the Niederdonau Gesellschaft m.b.H. It was comprised of the five largest German oil companies (Itag, Preussag, Elwerath, Deutsche Erdoel A. G., and Raky-Daubia).

Between the time when the Germans took over full control (Aug. 1, 1940) and the end of German operation of the East Austrian fields (April 22, 1945), only two new fields became productive. Both the Maustrenk and the Muehlberg fields were mapped and explored before the German management took over. The German firms, though, were the first to possess the funds to drill at any cost.

The German firms engaged, especially during the second part of the war (1942 to 1944) in high-pressure exploratory work, often in remote areas but—interestingly enough—never in the Matzen area. (The Matzen-Auersthal producing area accounted for almost 75 percent of Austria's 1955 crude production).

The high demand of the German war machinery for oil brought about the fact that by 1944 the original Austrian oil fields (around Zistersdorf) were drilled up. No increase could be expected from there. The forced production raised annual output over the 6,750,000-barrel mark during 1943—as compared with 223,040 barrels during 1937.

Discrimination against Anglo-American firms was at its height then—since Germany had also declared war on the U. S. (1941), and RAG had become an "enemy" company—though it was forced to produce for Germany (1943 yield, 7,492,480 barrels; 1944, 8,237,340 barrels).

Soviets Take Over. The Supreme Headquarters of the German Wehrmacht had forbidden any destruction of East Austrian oil production or processing units. While

FIGURE 2—Here is Lobau refinery's Danube river harbor, from where two-thirds of the Austrian compensatory crude shipments to Russia, East Germany, Hungary and Czechoslovakia were shipped.

production and refining worked at full speed up to the last days before the Red Army's capture of the installations, only a few rigs were moved farther West.

The Soviets began dismantling equipment. Vienna sources estimated the cost of replacement of the "transferred" material at between $8 million and $10 million, 1950 value. A private estimate said that 83 percent of all drilling installations and 35 percent of all compressors were shipped to the Soviet Union.

The dismantling period lasted until the second half of August, 1945, when, according to the Potsdam Agreement, the Soviet Union was given full ownership of the German Foreign Assets in Austria and several East European countries.

This new situation prompted the Ministry of the Petroleum Industry of the USSR to allocate several U. S. drilling rigs (delivered under Lend-Lease pacts via Vladivostok) to Austria. They arrived in the original U. S. cratings.

Losses in material, shortage of experienced personnel, and consequences of the forced German production were felt during the first postwar years. It took the Soviets three years to reach the 6,750,000-barrel mark again (1949: 7,850,580 barrels), but output rose quickly from then on.

The legal battle for Austrian oil, fought on an international level, is well known. In 1946 the Soviets offered a 50 percent share in a joint company (a parallel to Sov Rum Petrol in Rumania and MAORT in Hungary), but Austria refused, claiming Soviet ownership of the Austrian oil resources was illegal.

To block Soviet expansion, Austria included the entire Austrian oil industry in the 1946 Nationalization Act. While this did not change the actual structure of Austrian oil ownership, the Soviets were forced to deal with the Austrian government rather than with private firms which may have raised objections or brought forward complaints.

The Soviet Mineral Oil Administration was founded during October, 1945. A direct branch of the Moscow Ministry of the Petroleum Industry of the USSR, SMOA was entirely extra-territorial. It not only managed the German Asset enterprises but also exerted rigid control (as to deliveries and prices, allocations to refineries and adherence as to Soviet rules) over the Western oil companies (RAG and Van Sickle) which were "de jure" nationalized, but actually exempted from public administration owing to the extra-territorial status of the company's owners. (Four-power occupation countries had decreed such extra territorial status for all their citizens and business enterprises).

Much has been written about the physical dangers, shortcomings and difficulties that accompanied Soviet

control in Austria. Oil workers were the core of Communism in Austria; 40 percent of the 9000-plus oil workers were registered Communists, and another 40 percent were fellow-travelers. Ambush and riot troops were formed from oil workers during several Communist-inspired demonstrations betwen 1945 and 1955, Viennese sources said.

After the handing over of the Austrian oil installations to a team of four public administrators (Aug. 13, 1955), Communist terror has been reported at the refineries of Lobau and Vosendorf, while Communist posters, banners and slogans are still in oil enterprises. So far, nothing has been done by the managers of the Austrian Mineral Oil Administration to abolish this terror.

Austrian Oil Struggle. Provisions of the original Austrian State Treaty favorable to Russia called for long-term control and influence, large concession areas registration as legal business and a status of extra-territoriality in certain respects (transfer of funds, etc.).

These provisions were verbally waived when an Austrian government delegation appeared in Moscow during April, 1955. A direct exchange of the fields for 6,788,000 barrels of oil per year for a ten-year period, was agreed upon. Strangely enough, however, the USSR demanded that the original provisions concerning the oil industry be contained in the final state treaty draft, whereas the Moscow Agreement provisions were attached as an annex, along with the statement that the annex makes invalid the original provisions.

The Soviets handed over the fields in good condition, though equipped with mostly either old foreign material or post-war material originating from Soviet-managed Austrian firms (the Trautzel drilling equipment factory, for example) or with Soviet or Czech equipment (drill bits or seamless pipe).

The Austrians, in turn, took over the hottest item any Austrian government has faced economically since the establishment of the Republic in Austria (1918). Now, the Austrian Federal Republic is responsible for the future of the Austrian oil industry.

This includes the delivery to Russia of 67,880,000 barrels of crude, free of charge when delivered at the Austrian border, satisfying the restitution claims of Western oil companies and, basically, deciding upon the future organizational form of the Austrian oil business. This heritage has turned out to be most tricky, for Soviets did not lose a cent in managing Austrian oil during the period from 1945 to 1955 (even counting in all investments made in Austria which at present ships 32 percent of its annual output to the Soviet Union or, on Soviet orders, to East Germany—the Luetzgendorf refinery there depends on Austrian crude—to Poland—Polish tank cars pick up oil in Vienna—or to Czechoslovakia or Hungary).

Oil prices in Austria are government-controlled; the level is very low, prohibiting large reserve funds, rates of profits or funds for investments. Yet 32 percent of the oil produced must be delivered free of charge to the East. The struggle over whether the AMOA is supposed to pay for these deliveries by itself (thus cutting all investment reserves to the bone—no profits have been paid since 1937) or whether the Austrian state is to buy the crude from AMOA for delivery and thus enable the AMOA to further develop the fields and/or refineries has not yet been decided.

Soviets Profited. Another item in the current struggle between the two coalition-government forming political parties (the private-enterprise, conservative People's Party and the "nationalize-all" Socialist Party) is the fate of the Anglo-American firms operating in Austria.

The People's Party wants to reinstate these firms (RAG and Van Sickle) and reimburse them for lost profits by giving them concessions in southern and western Austria, as has already been done in the case of the two companies.

The Socialists want Austria's oil for the Austrian State.

Since the viewpoint of neither party would permit, despite discussions which lasted for weeks, any compromise, the Austrian Assembly was dissolved seven months before the normal time, and new elections decreed. These elections are already called "Erdoel Wahlen" or "oil elections." It is believed that the unaltered policy of the election-winning party will automatically become the overall new status of the oil industry—permitting slight alterations that would be called a "compromise."

This is the situation resulting from the signing of the Austrian State Treaty. As said, the Soviets emerged clearly ahead. Table 1 compares production during the German period (1938 to 1944) and the Soviet era and the domestic consumption. The gap between production and consumption was exported for Soviet profits, partly in crude form, partly in the form of derivates.

It appears, according to Table 1, that the Soviets shipped almost 100 million barrels of crude and/or products to other countries without asking for Austrian permission or export licenses, without surrendering the foreign currency gains and without accounting in any way to Austrian governmental agencies.

The average crude price per metric ton (metric ton = 6.788 barrels) delivered in Austria amounts to about $17.50. The total turnover of the Soviet Mineral Oil Administration in exports alone would amount to about $243,250,000.

Since an undisclosed percentage of exports was in the

TABLE 1
Russia exported almost 1 million barrels of Austrian crude without permission.

Year	Production	*Consumption	Soviet Exports
1938	384,744	.....	.....
1939	981,273	.....	.....
1940	2,799,738	.....	.....
1941	4,234,456	.....	.....
1942	5,890,606	.....	.....
1943	7,492,479	.....	.....
1944	8,237,340	.....	.....
1945	3,066,160	25,251	3,040,909
1946	5,744,073	2,174,000	3,570,074
1947	6,186,604	2,561,499	3,625,159
1948	6,458,212	2,349,524	4,108,688
1949	7,850,885	2,521,199	5,329,686
1950	11,535,690	3,637,805	7,897,886
1951	15,499,142	5,486,489	10,012,653
1952	18,759,921	5,981,402	12,778,519
1953	21,864,100	6,845,705	15,018,396
1954	23,406,395	8,227,524	15,178,871
1955†	24,885,568	8,653,750	13,516,619

*** Soviet exports for first half of 1955 estimated. Austrian compensatory deliveries totaled 2,715,200 barrels.**

† Consumption figures do not mean total consumption since all imported quantities have been subtracted.

form of products this sum is believed to be actually between 20 and 25 percent higher if part of the crude sales yields are deducted and the yield from the products exports is added. (This would amount to about $291.9 million to $304.06 million). When adding the value of oil products deliveries to Austria (via the OROP Soviet distribution company), about $120 million for the entire 1945-1955 period, Soviet turnover was about $417,-981,000.

What the Soviets did for this money was to explore the Matzen area, (among other large areas) finding what is termed the richest central- and west-European oil field known to date. The material brought into Austria under Soviet management was either amortized long after it was purchased, or was paid for by Austria ($19,460,000 worth of material was paid for by Austria when the Soviets demanded an even higher sum in compensation for equipment stored unused in the Central Oil Warehouse of the SMOA and such equipment as arrived before the actual handing over of the SMOA property during August, 1955).

Austrians Take Stock. Austria's fields produced a total of 175,630,092 barrels of crude from 1932 to the end of 1955. This yield is divided by fields as shown in Table 2.

The 1955 production amounted to 24,885,568 barrels. Table 3, with the 1938 output of the same fields, shows the decline in original fields around Zistersdorf and the development of new fields.

Gas Role in Austrian Economy. Proven natural gas reserves amount to 1,267,729 million cubic feet. This estimate is based largely on the gas field evaluation which follows:

1. Kagran and St. Marx: Two wells were drilled during 1955 near Kagran of which Breitenlee 5 made headlines by producing under 1800 psi. Since oil was produced along with the gas, seals were placed over the well to permit further studies as to whether Kagran contains oil as well as gas.

One well was drilled near the St. Marx cemetery during World War II. While its output was small, the gas was welcomed during the war. The field is not in production now.

2. Overlaa: Drilled by "Eurogasco" during 1932 and 1933, two wells started producing but went dry as soon as a gas pipe line to Vienna was finished.

3. Zwerndorf: This is the largest Austrian gas field to date. It is located between Zwerndorf and Schwaz. Gas-containing sand is found at a depth of 4921 feet, the field is estimated to be 4627 square miles in size. Zwerndorf Well 1 (Soviet Mineral Oil Administration) blew out, and from March 15, 1952, to February 24, 1954, about 35,310 million cubic feet forced its way through the crater that was once a well. A turbine rig was placed nearby and by drilling at 30 degrees the original well bottom was reached and sealed with cement. The 1955 output was about 3850 million cubic feet from four wells.

4. Fischamend: One well erupted during 1935 (Eurogasco); two other wells drilled by German companies during the war proved unproductive. SMOA drilled down eight wells between 1952 and 1954 (up to 8200 feet), but found only a few small gas deposits although SMOA hoped to find oil. Gas now is found at about 1624 feet.

The Austrian Federal Ministry of Transport and Nationalized Industry has agreed on the formation of a study group for the utilization of gas, headed by Dr. Friedl (one of the public administrators of AMOA). It will explore possibilities for the increased utilization of East Austrian gas. This is to be done not only with gas in mind as a primary source of energy, but also as a basis for a (so far non-existing) petroleum-based chemical industry.

Lower Austria province's NIOGAS Company is a competitive project. This public enterprise (majority-owned by Lower Austria province) wants to utilize the vast natural gas resources found on its territory in East Austria. The existence of two rival gas utilization bodies is also part of the major oil dispute that led to the dissolving of the Austrian Assembly. —**The End**

TABLE 2
From 1932 to end of 1955, Austrian oil fields produced more than 175 million barrels.

Field	Production (Barrels)
Muehlberg	22,376,703
Alt-Liechtenwarth	31,714
Plattwald	371,779
Van Sickle	7,289,973
St. Ulrich-Hauskirchen-Niederdonau	25,403,717
Neusiedel	179,549
Kreuzfeld-Pionier	111,948
Maustrenk	1,454,254
Goeting	10,925,985
RAG	5,002,023
Gaiselberg	16,514,593
Windisch-Baumgarten	3,991
Schrafeneck	24,273
Hohenruppersdorf	111,921
Rabensburg	7,514
Matzen (Bockfliess, Auersthal, Prottes)	76,523,982
Aderklaa	9,161,866
Suessenbrunn	134,307
Total	175,630,092

TABLE 3
Zistersdorf fields decline while Matzen leads in new-field production.

FIELD	1955 Owner	1955 Production	1944 Production	1938 Production
Muehlberg	AMOA	2,230,550	334,825	.....
Lichtenwarth	AMOA	2,206	.....	.....
Plattwald	Van Sickle	32,114	35,067	.....
Van Sickle	Van Sickle	203,606	103,313	.....
St. Ulrich-Hauskirchen	AMOA	658,999	4,304,956	8,906
Kreuzfeld-Pionier	EPG	8,465	18,633	.....
Maustrenk	AMOA	37,334	266,646	.....
Goesting	EPG	282,449	814,472	240,092
RAG	RAG	111,554	362,920	.....
Gaiselberg	RAG	602,374	1,465,034	1,263
Hohenruppersdorf	AMOA	4,453	11,519	.....
Rabensburg (1955)	AMOA	7,514	.....	.....
Matzen et al	AMOA	19,502,895	.....	.....
Aderklaa	AMOA	1,190,656	2,803	.....
Suessenbrunn	AMOA	8,363	.....	.....

a WORLD of OIL

AUSTRIA: Preliminary 1956 production estimates indicate that last year's total crude output will not exceed 22.4 million barrels, or about 2.4 million barrels less than in 1955 . . . The 13.66-mile Bockfliess-Korneuburg pipe line, which was designed to move up to 8 million barrels of crude annually from the Matzen-Bockfliess-Auersthal oil fields to the Korneuburg refinery, was scheduled to have been commissioned by the end of 1956.

AUSTRALIA: The first offshore oil exploration license granted by the Victorian Mines department was issued to Woodside (Lakes Entrance) Oil Company to permit the search for oil to begin in the coastal area of South Gippsland. This grant is Woodside's third permit in the South Gippsland area.

BRITISH HONDURAS: British Honduras Gulf Oil Company has released the Santa Fe Overseas Drilling Company rig after completion of two dry holes below 6000 feet; however, Gulf's geologic exploration will continue.

BULGARIA: Outstanding success has been reported on the acid treatment of 18 wells located near Tjulenovo . . . Radio Sofia announced that the 1956 yield of oil probably would reach 1.4 million barrels . . . The nation's first crude pipe line, a 93-mile project from Dobrudga fields of eastern Bulgaria to the Black Sea harbors near Stalin City, will be started shortly.

CANADA: Lowlands Exploration Company, an Imperial Oil Company subsidiary, was scheduled to drill a wildcat test—Lowlands 2—on the south shore of the St. Lawrence River across from Three Rivers. The location is about 80 miles downstream from Montreal . . . The first well in the area, located near Leclercville, was abandoned at a depth below 3300 feet . . . Evaluation of Lowlands holdings has been done previously by gravity and seismic work.

CYPRUS: Iraq Petroleum Company reportedly was negotiating for a concession in the offshore areas toward Turkey as interest in oil possibilities increased despite the powderkeg political and civil situation in the eastern Mediterranean.

CZECHOSLOVAKIA: Thirty wells are scheduled to be drilled in the south around Stefanov, Petrova-Ves and Broska as a result of the geological study of the area which has been continuing for the past year.

ECUADOR: South American Gold and Platinum Company, a recent entrant into the Ecuador crude production picture, reports good results from formation fracturing; however, details were not available.

ENGLAND: British Petroleum Exploration Company was drilling a wildcat test at Crawford, north of Liverpool and inland from production at Formby. Exploratory wells in this region have been drilled to 7000 feet and deeper.

FRANCE: Societe des Petroles de Valence has acquired a new exploration permit, totaling 247 square miles, in the Avignon-Orgon area of southern France.

GERMANY: The exploratory well, Harme 1, drilled by Mobil Oil A. G. and Gewerkschaft Brigitta about 4½ miles east of Vechta in Oldenburg province, was brought in as a 125 barrel daily producer in the Kimmeridge sand between 6050 feet and 6070 feet . . . Total West German production during the first nine months of 1956 amounted to approximately 18.3 million barrels.

HUNGARY: The 1951-commissioned Nagylengyel oil field, which produced about 80 percent of the total 1955 Hungarian production of 10.9 million barrels, is rapidly declining . . . A 2.4 million-barrel reduction was decreed in planned crude production for 1956 because of the decline in Nagylengyel field . . . Lovacs Oil Administration has reported the drilling of a well to the depth of 12,927 feet—Hungary's deepest well . . . A team of geologists left Budapest recently to fulfill a two-year contract in Red China.

INDONESIA: A reported agreement with Russia involves a Soviet trade mission being set up in Djakarta. The Soviet news agency Tass listed a number of Indonesian products, mostly agricultural, to be traded for Russian industrial equipment, including pumps, compressors, surveying, oil drilling and refining equipment.

IRAN: Sixty oil technicians reportedly have begun geological and geophysical exploration in the northern part of the country along the Caspian Sea for National Iranian Oil Company, according to the Middle East Economist.

IRAQ: An agreement has been signed with Kuwait to exchange oil information with the purpose of unifying "policies in dealing with oil companies operating in the region and to exchange technical information in regard to oil production and marketing" . . . Iraq has a similar agreement with Saudi Arabia, dating from 1953, and has said it would seek similar pacts with other Middle Eastern oil-producing nations.

ISRAEL: New regulations allow depletion allowance provisions equal to those of the U. S. and Canada to oil operators and makes such tax allowance retroactive to the commencement of oil exploration by operators.

NEW ZEALAND: Todd Brothers reportedly has staked a location for a wildcat test on a gravity prospect near Greymouth on the west coast of South Island.

NIGERIA: British Petroleum Co. and Royal Dutch Shell interests have discovered oil in the second test drilled at Oloibiri in the Niger River delta, and additional drilling was planned to evaluate findings . . . A second test on the Akukwa structure in Onitsha province, has been commenced. Scheduled to be drilled to 12,000 feet, it will probe formations which yielded high pressure gas in the first well in 1955.

PAKISTAN, WEST: Hunt International Petroleum Company has made location for a wildcat test at Dhak on the Mekran coast, 90 miles from Karachi.

PANAMA: International Oil and Metals Corporation of Seattle, Wash.,

has acquired 75 percent interest in a large southeastern Panama concession from Compania Petrolera del Golfo de Darien. The concession borders on Colombia and includes part of the Gulf of Darien.

PHILIPPINE ISLANDS: San Jose Oil Company of Manila has reported good results from the first phase of an airborne magnetometer survey of 2.5 million acres in Central Luzon, Panay and the Cotabato and Davao-Butuan regions of Mina Mindanao.

RUMANIA: Natural gas will be transported to Hungary under terms of an agreement signed recently.

RUSSIA: Reportedly, more than 100 wells were completed as producers in the Volga area during 1956, with the centers of production being listed as Muchanovo, Stavropol and Tshapajevesh . . . The Fergana Valley is the site of four new oil fields, discovered by 12 successful test wells . . . $20 million worth of oil will have been sold to Israel by the end of the fiscal year ending July 31, 1957 . . . It is claimed that Baskirian oil trusts have put 200 new wells into operation since the beginning of 1956.

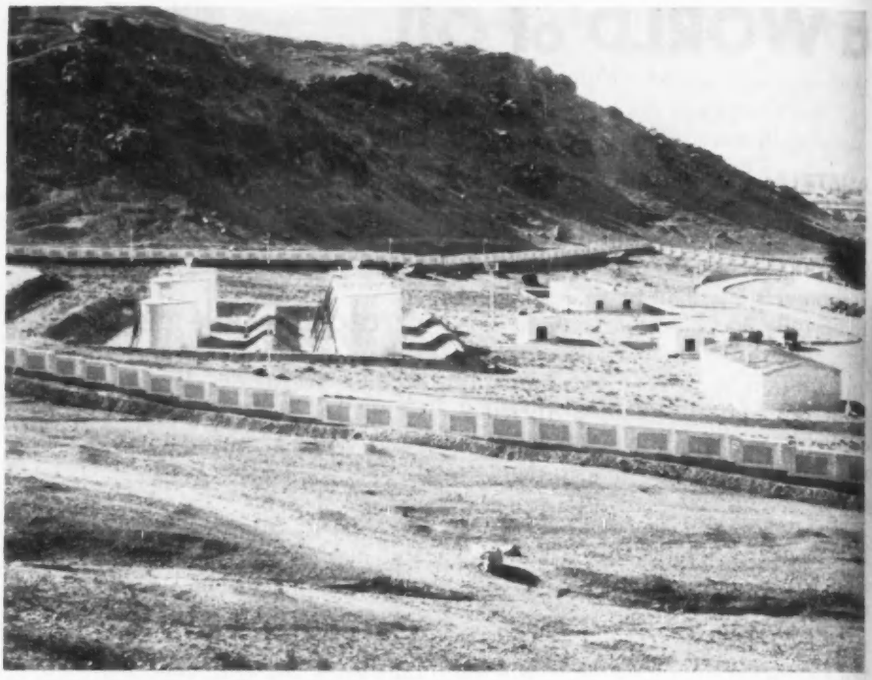
SICILY: Current crude production from Ragusa field amounts to almost 15,000 barrels daily, with an increase due shortly upon completion of a pipe line to Augusta and the putting into production of more producing wells.

SYRIA: The government reportedly has been reconsidering a Czechoslovakian offer to build a 20,000-barrel-a-day, $16 million refinery. Tenders from eight nations had been received . . . The government has granted a 5850 square-mile concession in the northeastern part of the country to Societe des Petroles Concordia of Damascus, affiliated with Deutsche Erdoel A. G. of Hamburg, Germany.

TURKEY: Deilmann Montan GmbH is continuing seismic reflection surveys in the European part of Turkey in Thracia province, and the most recent well drilled in this area reached 7624 feet. A second test was begun.

VENEZUELA: Creole Petroleum Corporation reportedly was making plans for the construction of a fourth repressuring plant in Lake Maracaibo —Tia Juana 4 . . . Venezuela Syndicate has bought out Talon Petroleum C.A., which was 12th among the 14 Venezuelan crude producers in 1955 with an average daily yield of 1694 barrels.

YUGOSLAVIA: Exploration drilling which has been continuing since October, 1955, paid off recently when a well near Filovac (Mur River island) hit an oil and gas deposit of "considerable" size, with crude production expected to soon reach about 300 barrels daily.



Russian-Built Storage Tanks

Tangible evidence of extensive Soviet influence in the isolated kingdom of Afghanistan is this petroleum storage area which Russians built for the Afghanistan government. Located just outside Kabul, the capital city, the walled tank farm is illuminated at night.
—United Press photo by Staff Correspondents Earnest Hoberecht and John Hlavacek.

New Company Organized For Panama Operations

Texas American Oil Corporation, Midland, Texas, has formed a wholly-owned subsidiary company in the Republic of Panama to investigate the possibilities of the acquisition of potential oil and gas properties and concessions in this area.

The new company, Caribbean American Petroleum Corporation of Panama, S. A., will actively seek substantial blocks of acreage in potential oil areas of the Republic of Panama and evaluate acquired properties by geological and geophysical exploration and core drilling.

24.7 Million Barrel Output In West Germany Possible

During the first nine months of 1956, a total of 18,303,500 barrels of oil was produced in Germany for a daily average yield of slightly more than 50,000 barrels. During the latter part of the year, daily production was rising, and if the September level of 70,574 barrels daily was maintained for the rest of the year, total annual output was expected to reach 24.7 million barrels.

Final production of September was 2,107,000 barrels, 1625 barrels more than reflected in the preliminary report. Particularly satisfactory results were noted for the Weser-Ems oil area, where the best field of Dueste-Wietingsmoor produced more than 84,000 barrels for the first time.

According to statistical data of Amt fuer Bodenforschung, 217,986 feet were drilled during September. The drilling report included the successful oil extension wells Eilte West 3, Leiferde 4 and 5, Emlichheim Z 2 and Ampfing 14.

Footage Drilled in September, 1956	
Exploratory wells	57,998 feet
Extension wells	46,742 feet
Production wells	103,062 feet
Service wells	10,184 feet
	217,986 feet

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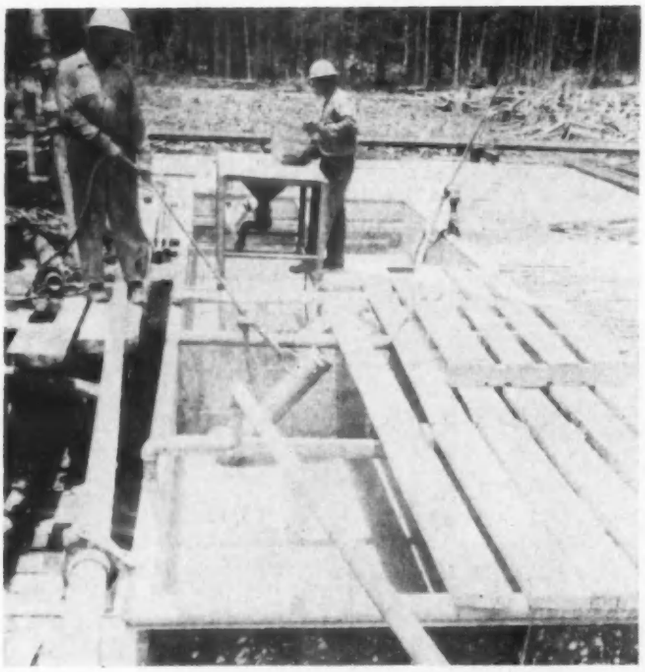
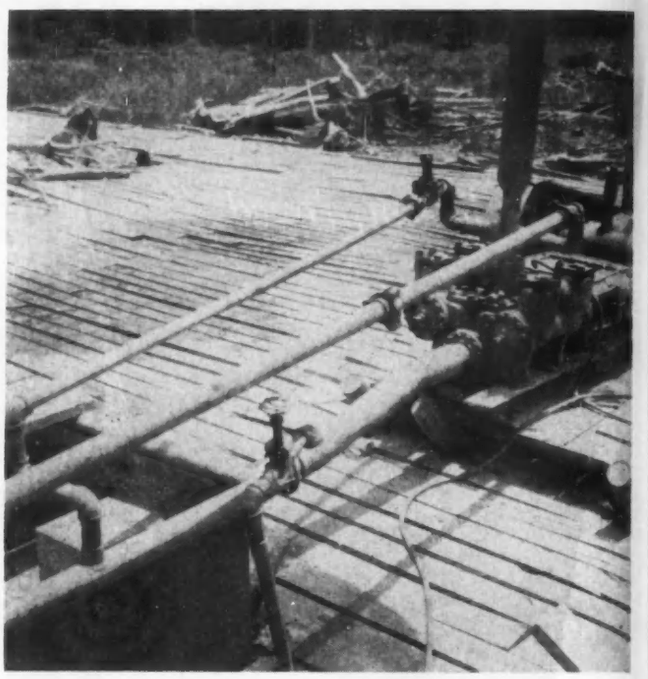
DRILLING HINTS

These **How-To-Do-It** Ideas Can Save You Money

$10 is paid for each illustrated acceptable contribution. Mail to The Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas.





Arrange Mud Tanks for Shallow Drilling and Workovers

By placing the skid mounted mud tanks end to end, both tanks can be moved in the same load and still stay within load limits. The tank shown in the foreground usually is filled with water when the hole is started and heavier mud is mixed in the compartment in the rear.

Whenever it is necessary to switch to the heavier mud, the swinging line (held by the crew member) is dropped and the mixed mud displaces the water in the tank and flows directly into the suction line. When it is desired to switch back to thin mud or water, the swing line is picked up and only the mud in the front tank is used.

The hookup to the mud pump is shown in the other photo. The suction line comes from the bottom of the tank to the mud pump and the discharge line on the right leads to the stand pipe. The discharge on the left is connected to the pipe which forms the top of the tank and leads to the mud mixing guns.

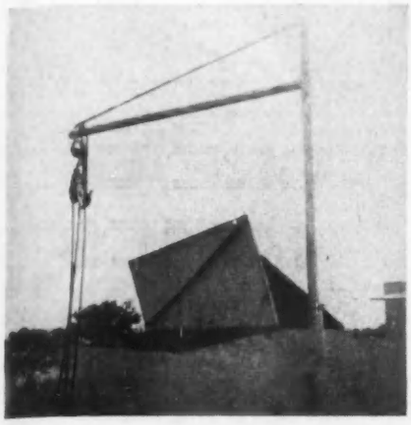
How-To-Do-It Ideas Earn Money, too!

$10—World Oil editors want how-to-do-it ideas, so your favorite short cut or invention could put money in your pocket! Write down the substance of that latest idea and send it in with a picture or drawing of the installation . . . if accepted, $10 will be yours. Send those money-making ideas today to Hints Editor, World Oil, P. O. Box 2608, Houston 1, Texas.

Measure Treating Chemical With Right Size Tin Can

One Gulf Coast boiler tender was having difficulty measuring the correct amount of treating chemical for his boiler water. He then located a tin can having the correct capacity and had the welder secure a piece of welding rod on the side of the can to serve as the handle. The whole

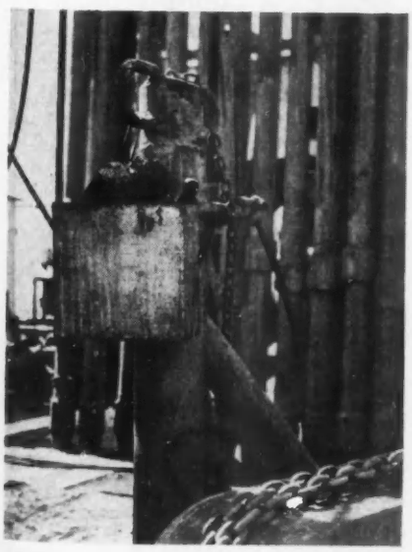
crew now has the cups for drinking purposes, measuring caustic, rig wash, etc.



Construct Fitted Hoist To Secure Big Pump Parts

It is difficult to secure large pump parts or engine parts from a deep parts box. For this reason a Gulf Coast contractor had a hoist built which could be fitted into the parts box when needed and removed when moving the rig.

As seen from the illustration, construct the hoist from two pieces of 4-inch pipe welded in the form of an "L" with a sucker rod for a top brace. Weld a hollow pipe larger than the hoist to the side of the parts box to receive the hoist. At the end of the hoist arm is a block and tackle with which the actual lifting is done.



Provide Special Holder For Measuring Tape

In the interest of good housekeeping, provide a special place on the rig for all tools and equipment. This is especially needed for small tools that are used infrequently, but should be readily available when they are needed. Such is the case of the measuring line. When strapping in and out of the hole, this line should be readily available on the floor and at the same time should be in a handy position where it can be used when adding new pipe. Take care of this tape as it can be easily broken by rough handling or misuse about the rig.

One operator has found a very convenient form of keeping this tape available, not only on the floor, but also to the crew when working the pipe rack and bringing in new pipe.

A small receptacle approximately seven inches square by three inches deep, is hung with a small bale to the back-up tong post that is positioned right near the pipe slide. When the tape is in use, but is laid down temporarily, it is always put in the box. It is out of the way, not trampled on or injured and is available either on the floor for strapping pipe, or at the slide for running in new pipe.

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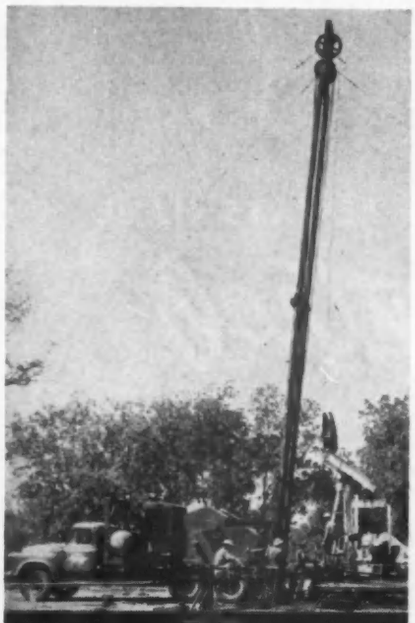

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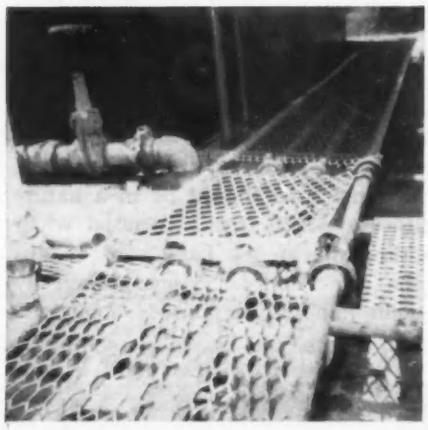
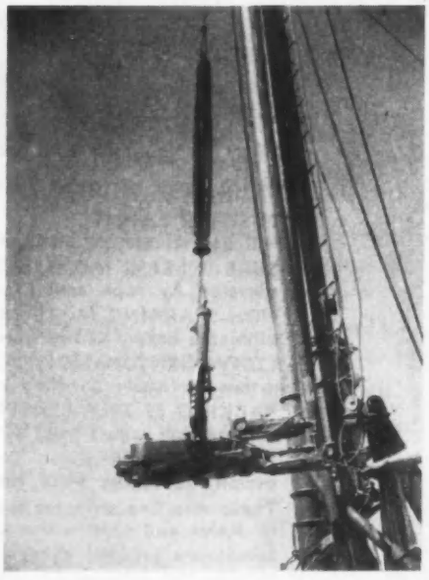


Use Fuel, Steam Pipes For Portable Walkway

On many rigs the equipment is situated so as to keep as many of the pipes carrying fuel, steam, water, etc., out of the line of traffic. One south Texas contractor has set up his equipment so the pipes will be side by side and right in the line of traffic. He has utilized the pipes as a foundation for a portable walkway.

Make the walkway in sections for easy portability. Construct the frame and make the flooring of iron mesh material. Hold the walkway in place by welding U-shaped supports to the frames.



Hay Baler Springs Serve As Tong Counterbalance

Where rigs are continually on the move, eliminate the additional wire cable and counterbalance weights by visiting a farm equipment store and purchasing a set of springs which are used in a certain make of hay bailer.

2
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SEE PAGES
204-205

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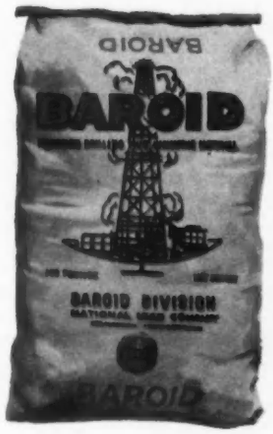

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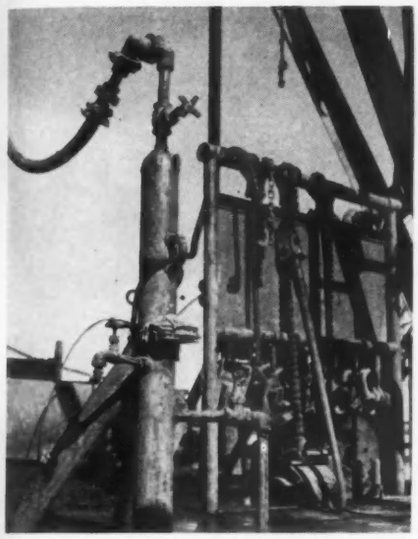
Group the springs in a set of three, the ends tied together and the tongs suspended on the springs. Where the tongs are not powered by air, one or two of the springs will suffice.

Connect them together by welding eyes to a plate on the end and a chain run from the bottom to the tongs. Run another chain to the side of the tongs to keep them level when in use.



Provide Soap, Wash Rack Around Drilling Floor

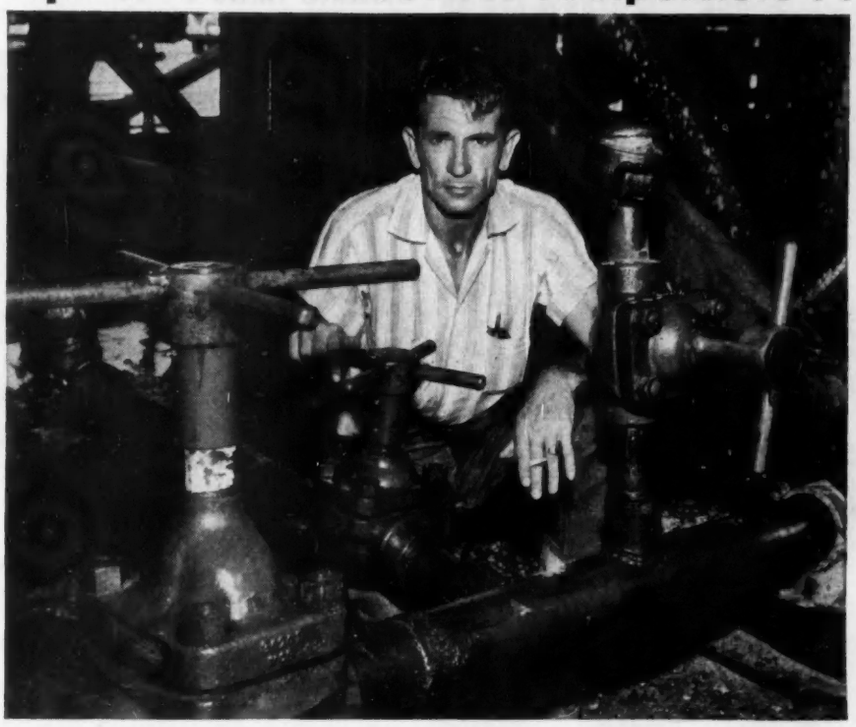
Most crews are accustomed to using the wash down hose to wash their hands or small hand tools, etc. One operator has found a convenient means of providing not only a source of water but a rack for soap or cleanser as well.

Obtain a 4-inch piece of pipe. Close one end and orange-peel the other around a 1-inch nipple. Weld suitable other couplings into this 4-inch pipe for water entry and discharge as noted in the photograph. Then brace this pipe to the drilling floor with other lengths of 4-inch pipe. Fit the wash down hose to the coupling at the top of the 4-inch pipe, which is above head height so that the hose will be out of reach and not as likely to be damaged.

Use 1-inch fittings to make a suitable discharge line in the side of the 4-inch pipe at a convenient height for the crew's use. Mount directly above this a shop-made soap dish that the welder can fabricate in his spare time.

This makes a handy place around the drilling floor for the crew to wash up before eating.

Tips on Mud Valves for Toolpushers . .



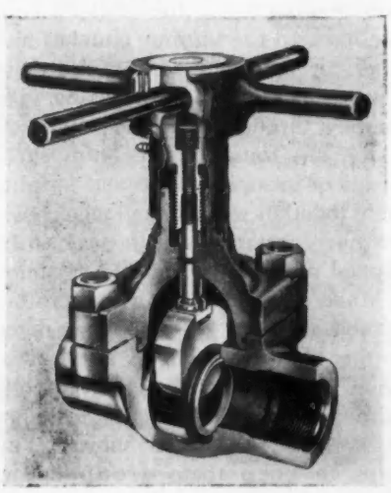
Bob Walker stops to look over a few of the MUDWONDER mud valves during rigging.

Veteran Oil Drillers Agree On MUDWONDER For Mud Valve Economy

By Robert Walker, Toolpusher, Rig #2
J. & B. Drilling Company, Eunice, Louisiana

WHEN your crew swears one mud valve is the best and the price tag is in line with other valves, logic says buy them. And, that's just what we did.

MUDWONDER cut-away view shows the double thread construction, separated stainless stem and hard chromed gate with "T" slot connection and the one-piece seat insert with the buna-N molded integrally over the steel wear rings.



Rockwell-Built MUDWONDER valves were put on all mudlines when the new "76" was rigged recently.

Past experience had proven the MUDWONDER valves as near trouble-free as a mud valve can be. So, it wasn't a difficult choice. Our vice-president, C. E. Bush, a veteran well digger, agreed that in sharply competitive contracting, J. & B. could not afford inferior valves.

The easy MUDWONDER operation, even at high pressures, and the long service life make it truly an "economy" valve. On the rare occasions when maintenance or inspections—even part replacements—are required, no drilling time need be lost. Mud valve work can be done while the crew makes a connection because the one-piece body stays in the line.

Two-inch and 4-inch MUDWONDER valves are being sent on our standpipe, mud guns, manifold, bleed-off, etc., with great success. Mr. Bush and the crew join in recommending MUDWONDER to any toolpusher having mud valve problems.

MUDWONDER valves are built in 2", 3", and 4" sizes with screwed or flanged ends for 2000 psi WP (4000 psi test) and 3000 psi WP (6000 psi test).

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(For more data on advertised products, use Readers' Service blue cards, last page this issue.)

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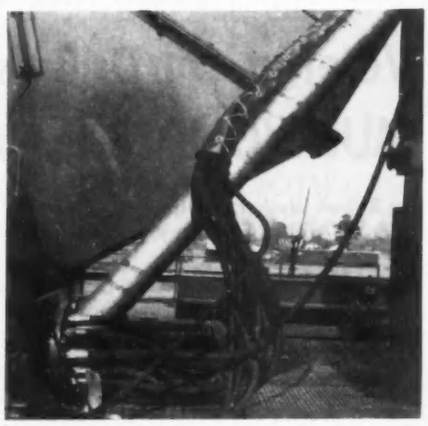

Provide Laced Jacket For Air and Fuel Lines

On modern rigs with all air controls leading from the driller's console back to the various clutches and other air operated equipment, there is a considerable maze of flexible hose running throughout the rig. One operator has found a very convenient means of grouping these and keeping them together so that the longer hoses are not constantly in the way to be tripped over or broken due to abuse.

Make a jacket of canvas or other suitable material grommeted as noted in the photograph. Run air hoses, where they can not be tied in directly to the substructure, together and lace within this jacket as shown. This helps to keep them grouped and

2 GREAT NAMES ARE JOINED!

SEE PAGES 204-205

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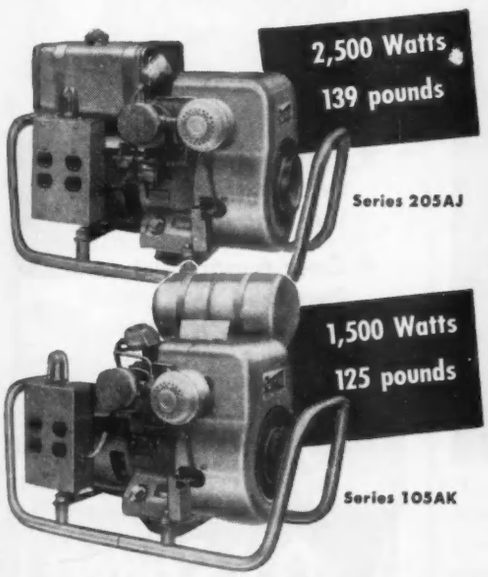

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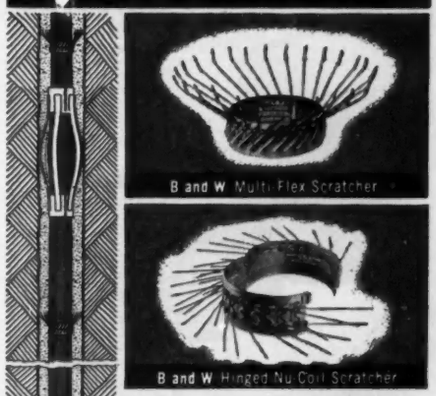

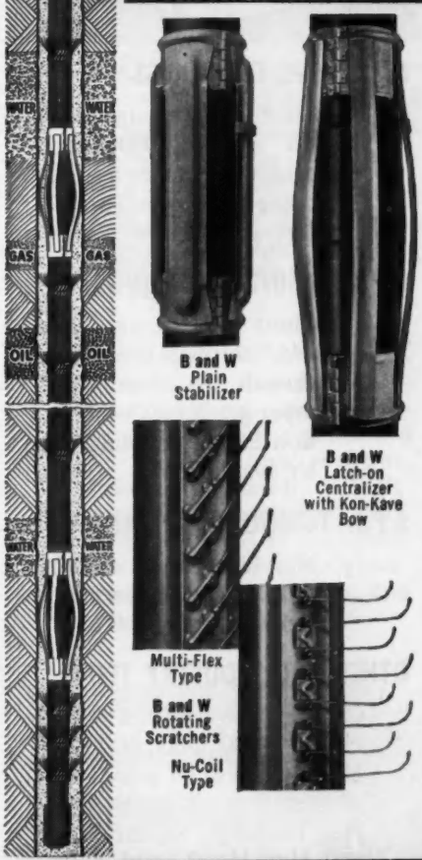
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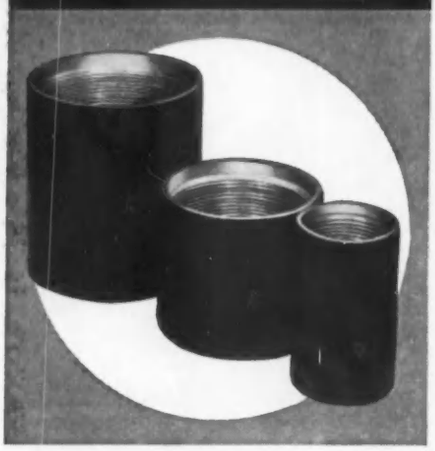

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forms them into one compact bundle that can be more easily handled and provides better housekeeping around the rig. This is preferred to the maze of 10 or more hoses that might be left lying around loose and provide a real safety hazard around the rig.

Fix Semicircular Support For Water Supply Pipe

When running lengths of pipe from water supply, fix supports to the side of the mud tanks and lay the pipe along these supports. Make the support from a piece of sheet metal bent into a semicircular shape. Weld this to a short piece of small diameter pipe which in turn is welded to the side of the mud tank.

Make Coffee Pot Holder From Lightweight Metal

To provide a handy warming spot for the morning cup of coffee, weld a small bracket around the top of the vertical portion of the dog house heater. Form this bracket, made of small rod or welding rod, in a circle and with the suitable braces extended

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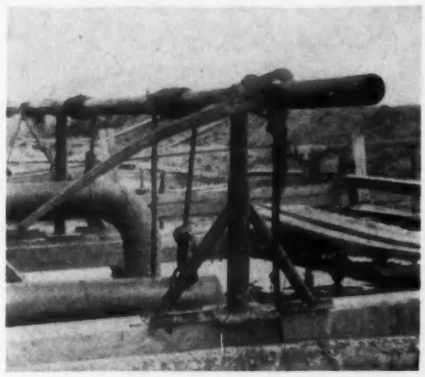
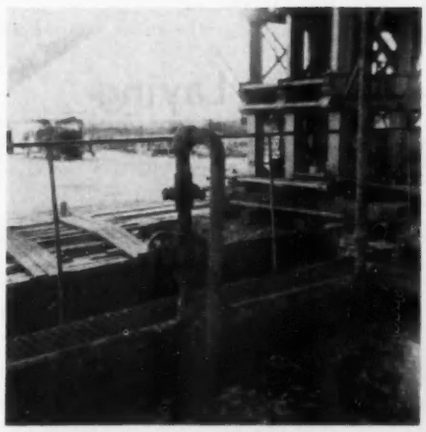
approximately 2½ inches above the top of vertical portion of the heater.

This provides a good safety feature and also is a mark of good housekeeping around the rig.



Set Up Shopmade Supports For Pump Suction Moving

To raise or lower the pump suction for slush pumps without a flooded suction, set up two supports, one on each side of the pumps. Lay a large pipe across these supports. Wrap heavy rope around the pipe several times, securing one end to the pump suction and leaving the other end free. By rotating the pipe with a lever the pump suction may be raised or lowered as desired.



Submerge Stationary Guns To Provide Good Agitation

Stationary mud guns when submerged will provide good agitation. These guns can be constructed as follows, starting from the mud line manifold: Gate valve, short length of pipe, hammer joint, short length of pipe, "L" joint, long length of pipe with a 90-degree turn at the top, another "L" joint, and a reducer at the end to make the jetting action.

Several of these guns will give good mixing even in a large mud tank.

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PRODUCTION HINTS

These How-To-Do-It Ideas Can Save You Money

$10 is paid for each illustrated acceptable contribution. Mail to The Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas.

Simple Pipe Chock Does Efficient Job

Make a more efficient chock of 1¼-inch angle iron cut in 2½-inch lengths. Cut notches into the sides of the angle iron, and file to form three sharp teeth. The teeth bite into the wood rack providing sturdy support.

These chocks are easy to handle, can be slipped into place quickly and are not difficult to make. In addition there is no worry about pulling spikes, etc., when the time comes to remove the chock.

Convenient Boom Speeds Pipe Laying

A detachable, welded pipe, boom such as the one illustrated can turn any flatbed truck into a helpful pipe laying unit. This handy frame, designed for light work, is made of 4-inch pipe with a 6-inch boom welded to the braces as shown.

Chains are used to attach the frame to the truck bed with the boom pointing aft for road travel. On the job the frame is rotated 90 degrees and it's in position for operation.

Two blocks are used for directing the cable. One is placed at the end of the boom, the other near the base directs the line to a winch located behind the truck cab. This unit is simple to construct, is flexible and will save considerable time on many jobs.

Pumping Unit Scaffold Increases Safety on Job

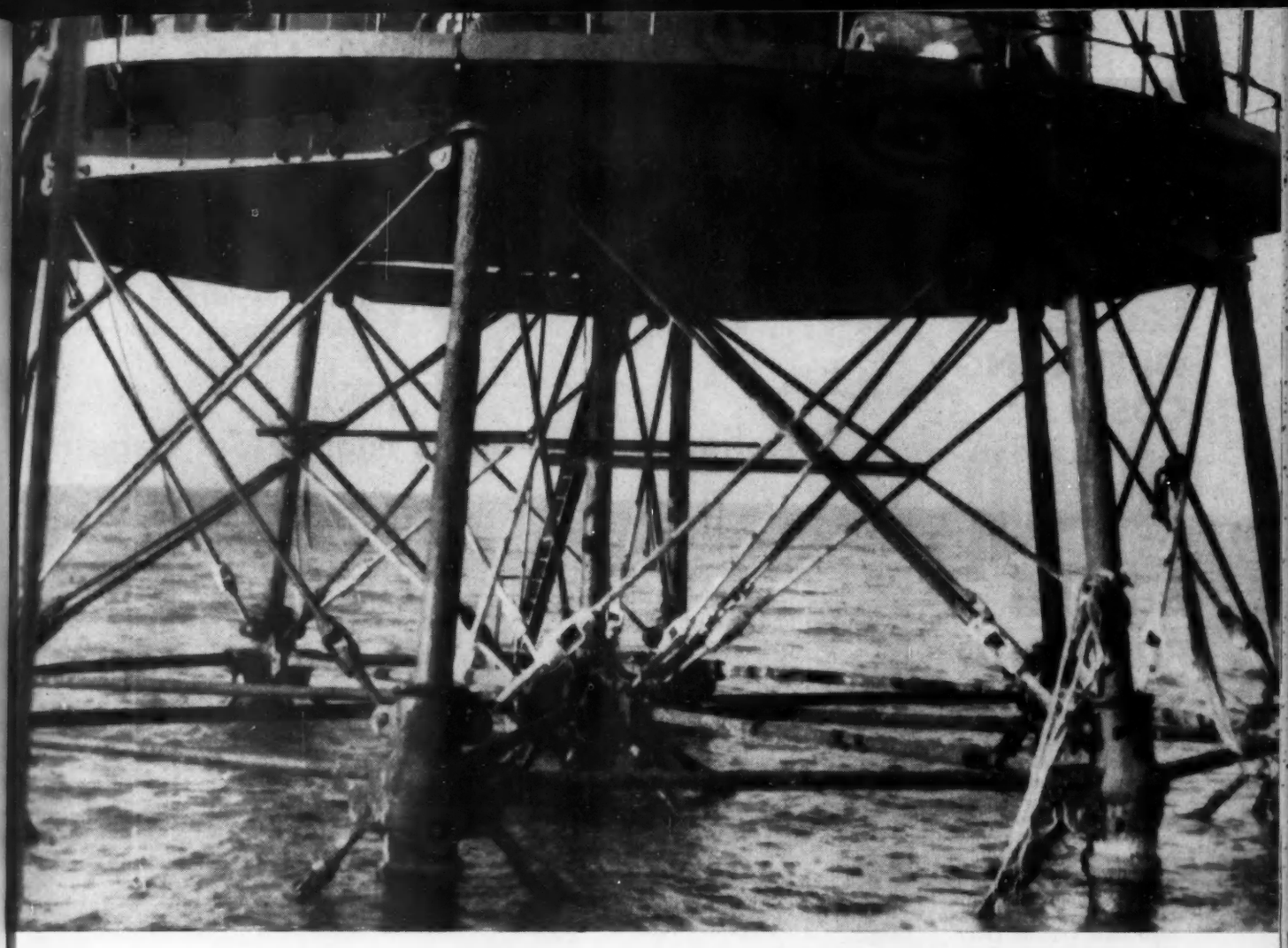
Lubricating bearings, adjusting weights or performing other maintenance activity on the walking beam can be a difficult and sometimes hazardous chore. To reduce the hazards and make his job easier one operator built the simple scaffold arrangement illustrated in the photograph.

The near end of the platform is supported by a short piece of 2-inch pipe welded at a right angle to a

How-To-Do-It Ideas

Earn Money, too!

$10—WORLD OIL editors want how-to-do-it ideas, so your favorite short cut or invention could put money in your pocket! Write down the substance of that latest idea and send it in with a picture or drawing of the installation . . . if accepted, $10 will be yours. Send those money-making ideas today to Hints Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas.



Rounding out a century of offshore service, these wrought iron vertical bars show no effects from corrosion

Wrought Iron vertical supports on Ship Shoal light have shrugged off corrosion since 1859

The offshore service record of the U.S. Coast Guard's Ship Shoal light offers convincing proof of wrought iron's outstanding durability.

For close to 100 years, vertical columns of wrought iron bars have supported this lighthouse off the coast of Morgan City, La. Rising from a 20-foot depth out of the Gulf of Mexico, the corrosion-resistant 8-inch O.D. metal bars extend to the living quarters deck.

Further evidence of wrought iron's corrosion resistance is the fact that no reduction occurred in the diameter of the columns. All these years of exposure to the severe corrosive effect of salt water and spray have failed to penetrate wrought iron's rugged defense.

We have many case-history records available which show how wrought iron is virtually immune to salt water attack in offshore applications. Write us for some of this information or call in one of our field service engineers.

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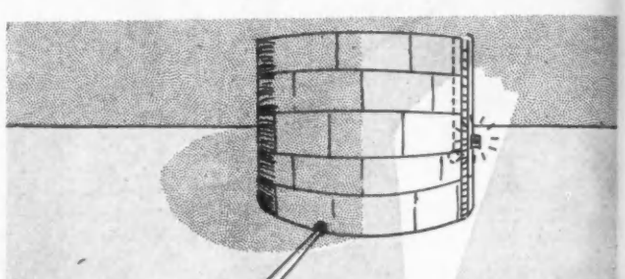
length of 4-inch pipe imbedded in concrete. The far end support, also made of 2-inch pipe, is welded to the sampson post.

Bolts are used to secure the planks, which make up the platform, to the supports. One inch steel rod is welded into the railing shown in the photograph as an additional safety feature.

This assembly is much more satisfactory than the ladders or steps in general use. It allows more freedom of movement, provides a place for tools and materials and will accommodate a number of men if required.

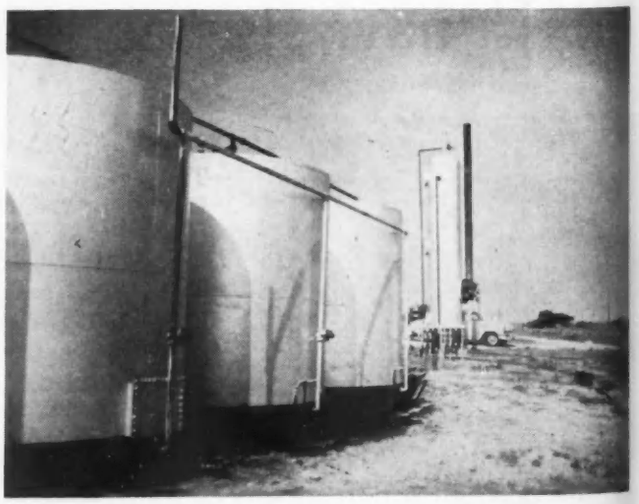
Reflector Tape Spots Night Float Gage

To fill stock tanks at night when the tanks visible float gage is some distance from meters and control valves, cover the target of the float gage with red reflector tape. A flashlight, shone on the target, will cause it to glow, making it easily distinguishable. This makes the operation simpler and eliminates the need for guess work on the part of the gager.



Install Additional Over-Flow Line Easily

When storage tanks in a battery have been installed one or two at a time as needs increase, it is easy to overlook the addition of an overflow line.



To solve this problem, cut holes in the cleanout covers and weld a flange in place while the individual tanks are being cleaned. Making the connection on the covers allows the welder to work away from the tanks, eliminating the danger of an explosion in the tank.

When the cover is replaced, install the piping up to and including the valve and return the tank to use. At a later date when all the tanks have been similarly equipped, install the remainder of the pipe connecting the tanks. Include a vent to prevent air locks, open the valve at each tank,

and the job is complete.

The height and convenience of the tank valves is another feature that makes this a worthwhile procedure.

Get Valve Out of Way But Still Accessible

Here is one simple way of eliminating the hazard of a valve handle sticking out of the ground quickly and still keep the valve handle readily available. Bury the handle deep enough to have the top at ground level or slightly below. Then cut a piece of 8 to 10-inch casing; or whatever diameter is necessary to allow access to the valve and long enough to reach from the top of the valve to the ground level.

Place the casing around the handle, as shown, packing the earth, gravel or shell back around it to hold it in place. This not only keeps the valve out of the way, reducing the hazards around the location, but also improves the appearance of the area.

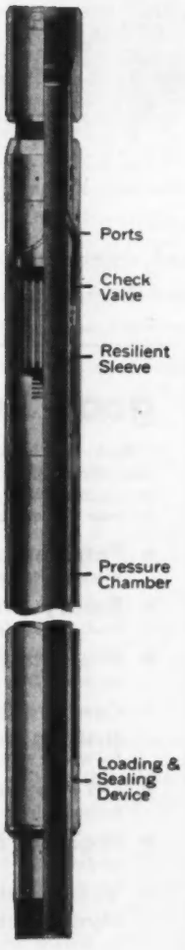
Replace Railing Gate With Simple Turnstile

If you have your hands full, it is often an inconvenience to have to open the gate in the railing or fence

TYPE C

"SLIM JIM" — 3 1/16" O. D. x 2" I. D.

OTIS GAS LIFT VALVE



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- In parallel-string installations, valve can be rotated with both strings in place
- The Type C can be operated as either a continuous or intermittent valve, simply by surface changes
- Special, normally-closed check valve within the flow valve affords positive protection against back flow into casing
- Three ¼" ports — a flow area almost *double* that of other valves

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(For more data on advertised products, use Readers' Service blue cards, last page this issue.)

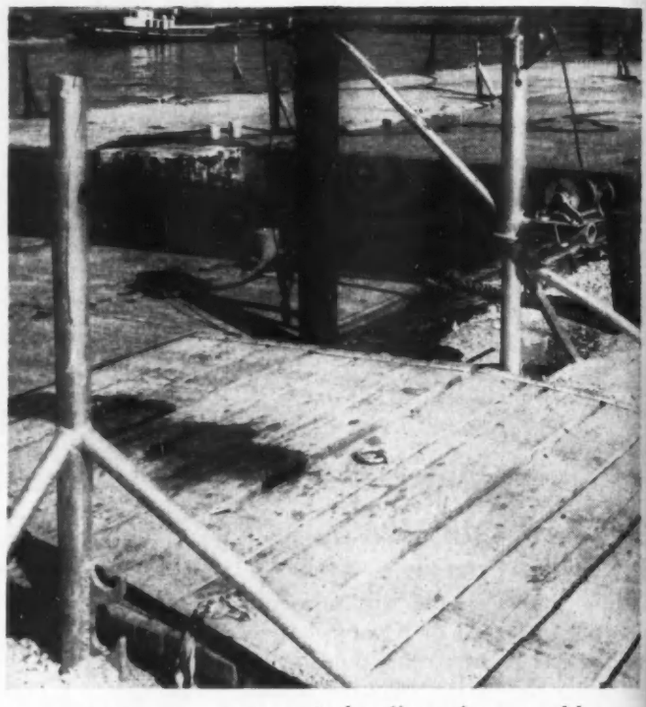
PRODUCTION HINTS . . .

around a well head to get in. One answer to the problem is a turnstile similar to the one in the illustration. It is easy to make, has a neat appearance, is less expensive than a gate of the same quality.

Use a quarter or ½-inch rod for the four arms. Bend them to fit the opening in the particular fence, and weld them into a single unit. Make the top or hub of the unit which acts as the bearing of a short piece of pipe closed at one end. It should be slightly larger in I.D. than the O.D. of the pipe on which it will fit. This allows for easy rotation of the arms. The guide ring at the bottom is made of the same size pipe as the hub. It need only be wide enough to allow the bottom ends of the rods to be welded in place.

An additional feature of this enclosure is the collars at the base of each post. This makes the job of setting the posts in concrete a simple one. The railing can be installed after the concrete footing is hard. It also allows the entire railing to be easily removed to admit workover units if necessary.

Build Flexible Ramp for Loading Barges



A real need along the Gulf Coast, where barges are a part of every day's activity, is a good loading ramp. Service company vehicle, supply trucks and personnel are often put in hazardous positions as a result of inadequate ramps.

The attached illustration is one answer to the problem. Here is a simple, sturdy unit that can be adapted to your particular needs. Hinged in the center, it can rise and fall with the tides. A small hand winch provides the means to raise and lower it as the situation demands.

The installation and construction of the ramp illustrated by the picture and the dimensions would vary to fit the situation. This finished unit, however, produces a much neater and safer job than a majority of these in use today.

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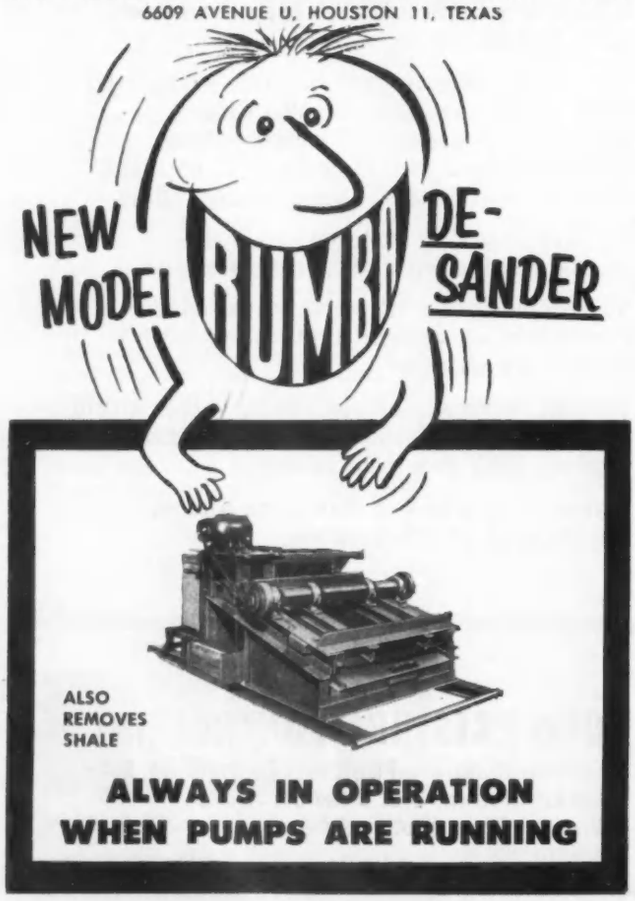

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- **Oil Property Valuation**
  by Paul Paine — Price $5.50
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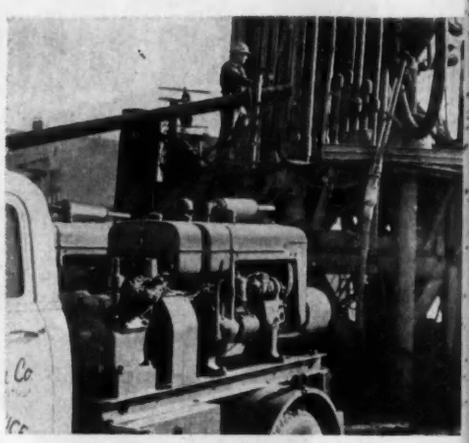

PUMPING...

NO FUEL COST PER HOUR! By using natural gas from the well, this International U-164 carbureted engine pays for itself in a very short time. It is one of 50 International engines pumping in an area less than half a city block, near Athens, Texas.

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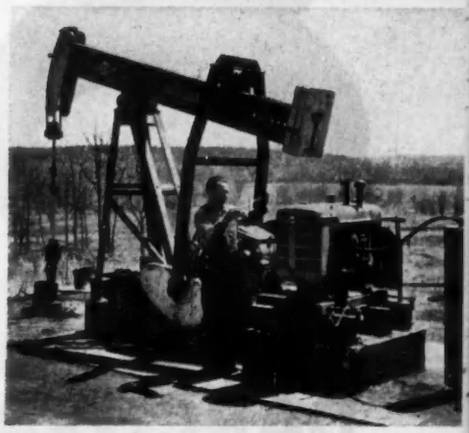

PIPELINING...

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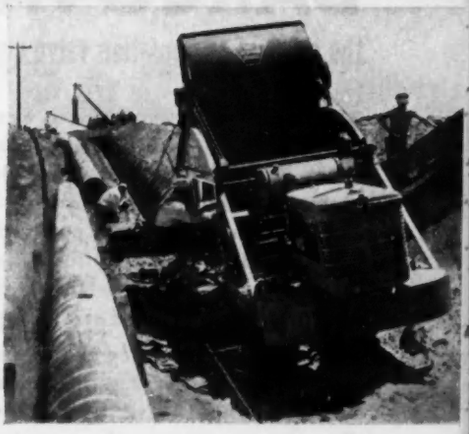
100% INTERNATIONAL POWER! Long, low-cost, dependable life are the reasons why Fred Linneman, Inc., Denver, Colo., uses nothing but International power on his pipeline spread. Parson's Trenchliner, here, uses an International UD-14A diesel engine, cuts 1,600 feet per day.



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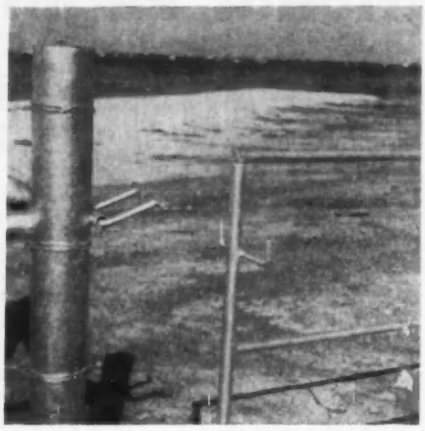

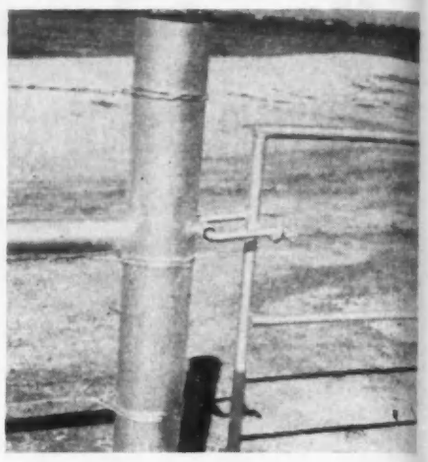

Make a Simple Latch for That Gate

Here is a suggestion for latching that gate on to the lease.

The gate is made of welded 1-inch rod with 5/16-inch rod used for the stationary part of the latch and ½ inch for the movable part. The only other material needed is a short length of ¾-inch pipe.

Cut a piece of pipe about 4 inches long, weld it in place on the gate post and slip a 15 to 18-inch piece of ½-inch rod through it. Bend the rod as shown being sure that it can move freely up and down.

The stationary part of the latch, shown on the open gate, is an 8- or 10-inch piece of the 5/16-inch rod formed to catch the moving part as illustrated with the gate closed. These two interlocking parts of the latch fit together snugly, thus keeping the latch from falling open leaving the gate free.

A system like this allows the gate to be opened easily from either side with a minimum of effort.

Put Cable Underground– But Label Its Position

It's a sad experience to watch pumping units and other electrical equipment on a lease come to a halt because someone has accidentally dug up a buried cable.

Shut-down time as well as repairs cost money, much more than the expense of putting up markers like this one. This sort of sign gives bulldozers and ditch-diggers a warning before

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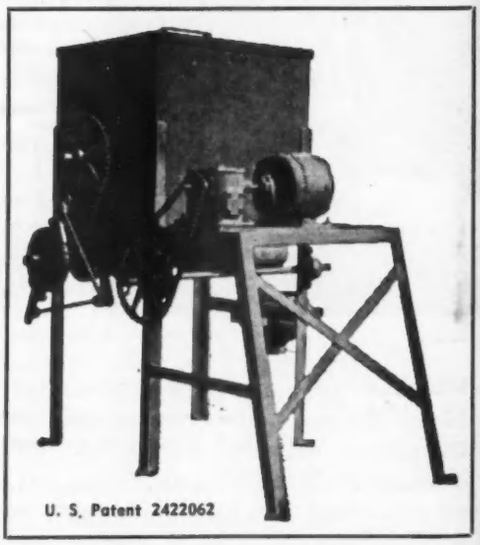
For complete description see Page 2777 of the Composite Catalog.



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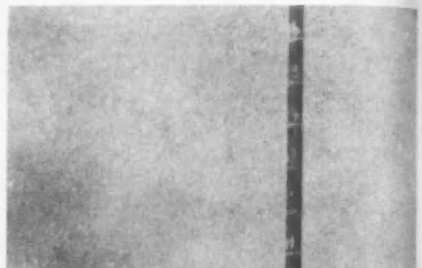
they find themselves looking at the mangled ends of a broken cable.

Don's let this be your experience. Bury that cable—but mark it.

Plow a Ditch with Pipe For Shallow Water Lines

A middle-buster type plow has proved itself an effective device for burying gathering lines in marshes and shallow water.

In operation the pipe runs on rollers through the frame attached to the plow above the blades. As additional joints of pipe are welded to the line,

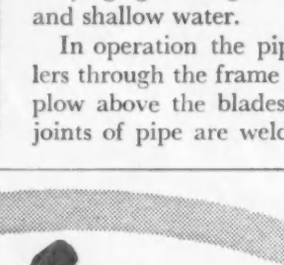


the lay barge is moved forward sliding the pipe off the end of the barge. When several lengths of pipe have been laid, the barge is secured and the plow is pulled forward. This job is done with a winch which spools in a cable attached to the plow. The forward motion of the plow, weighted by the pipe, causes the plow to dig a furrow into which the pipe is laid.

The vertical pipe above the plow is marked to gage the depth pipe below the surface of the water. For an efficient way to lay small diameter lines, this system is hard to beat.

Submitted by employes of Humble Oil & Refining Company.

13 SIZES



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What's Happening

AMONG MEN IN THE INDUSTRY

G. C. Carr, who retired December 31 from the post of manager, distribution, marketing operations, of **Shell Petroleum Co., Ltd.,** first joined the Shell group in 1934 as assistant chief engineer to the Eagle Oil & Shipping Co., Ltd. In 1940 he was made chief engineer and transferred to Shell Petroleum in 1952. Prior to joining the Shell organization, and following a period of 10 years as refinery and chief field engineer to the Attock Oil Co., Ltd., in the Punjab, he was in 1929 located in Los Angeles as oil field machinery designer to Emsco Manufacturing Co. In 1930 he returned to the United Kingdom and for three years was sales manager in London for Continental Emsco Co., Inc. Carr plans to continue his association with the petroleum industry in a consulting capacity. His home address is 16 Roehampton Close, London, S.W. 15.

G. C. Carr

•

Esso Standard Oil Company announced the appointment of **Frederick P. Hagaman** as controller of the company. He succeeds **Harold A. Koechling,** who has assumed added responsibilities as a member of Esso Standard's board of directors and will devote full time to his duties as a board member. Koechling was named controller of Esso Standard and a director of the company in 1944. Before that he was assistant controller of Esso's parent company, Standard Oil Company (New Jersey). Hagaman has been Esso's executive assistant controller since 1945, when Standard of Louisiana became a part of Esso Standard. He had been controller and a director of the Louisiana company.

•

Reese H. Taylor, board chairman of the **Union Oil Company of California,** was elected a director of the Westinghouse Electric Corporation. In 1938, he left the presidency of the Consolidated Steel Corporation, which later merged into the United States Steel Corporation, to become president and a director of Union Oil and its subsidiaries. He became chairman of the oil company's board of directors last August 1.

•

Gulf Coast Leaseholds, Inc., elected **Cecil V. Hagen** president of the company to succeed **Robert G. Behrman, Jr.,** who had resigned to enter the oil business for himself. Hagen, chairman of the Gulf Coast Leaseholds board, was one of the founders of the five-year-old oil firm. The board of directors also accepted the resignation of **William P. Swearingen,** vice president in charge of drilling and production, and elected three new directors to fill vacancies on the board. **R. L. Oliver,** controller of the company, was elected vice president. Oliver, a certified public accountant, was formerly associated with Price Waterhouse and Company. The three new directors are **Zack Pruett,** president of the Gonzales National Bank; **A. C. Mackay** of Houston, comptroller of Venezuela Syndicate, Inc.; and **Fisher Jones,** general manager of Corpus Christi Development Corporation and formerly with Pan American Petroleum Transport Company.

•

Tidewater Oil Company has announced a number of administrative and executive changes for the Southern division. **George R. Kinter** will be assistant manager of Tidewater's Gas Utilization department. He is being transferred from the company's Central division in Tulsa to take over this newly created job. Recently, **J. M. Tharp, Jr.,** who was district superintendent, offshore operations, in Tidewater's Houston headquarters, was transferred to the company's Western division. Replacing Tharp is **George H. Truran** who was moved to Houston from the Western division to fill the vacancy.

•

Albert A. Kirkbride was employed as district geophysicist for the Houston district of **Sohio Petroleum Company.** He will report to **Brooks Stewart,** Gulf Coast division geophysicist. Kirkbride has had wide geophysical experience in the Gulf Coast area covering 20 years in operations, interpretation and administrative work.

•

Leo C. Gravis has joined **Trunkline Gas Company** of Houston as chief geologist. Gravis will direct Trunkline's exploration activities, to be carried out primarily in the Texas and Louisiana Gulf Coast areas. Before coming to Trunkline, Gravis was Gulf Oil Corporation's manager of exploration for the offshore-Gulf of Mexico zone. He joined Gulf as a geological draftsman.

Leo C. Gravis

•

A. H. Weyland was elected vice president of **Arkansas Fuel Oil Corporation.** He is production division manager and will continue to head that phase of the company's activities. Weyland's association with the Cities Service organization began in 1919 when he joined the Empire Companies at Bartlesville, Okla., as junior engineer. He became superintendent of oil production for Arkansas Fuel in Shreveport in 1928 and later held various executive positions in that company and its affiliates. When Arkansas Louisiana Gas Company was separated from the Arkansas Natural Gas Corporation and the Arkansas Fuel in 1953, Weyland continued as president of the gas company and was subsequently elected chairman of the board. He later retired from that position. In 1956, he joined Arkansas Fuel as a consultant and was named manager of the Production division in July, 1956.

Thomas F. Phelan

Charles D. Freeman

Charles D. Freeman, Sun Oil Company veteran of 32 years, succeeded **John P. Morgan** as tax commissioner for Sun's Production department. **Thomas F. Phelan,** senior tax man, succeeds Freeman as assistant tax commissioner for Production. Morgan, tax commissioner for 27 years, is retiring because of his health. The tax commissioner for Production and his staff maintain offices in Sun's Southwest division headquarters in Dallas, but also serve other Production divisions throughout the U. S. and Canada. Freeman joined Sun in 1924 as secretary to the late vice president for Production, **J. Edgar Pew.** He moved into the Tax department two years later, and has been assistant tax commissioner since 1927.

•

Carl C. Russell, general accountant for **Sinclair Oil & Gas Company,** has been named head of the Electronics Computing section of the Accounting department. The Electronics Computing section has been operated as a department since its organization more than two years ago. When **Charles S. Larkey,** manager, retired, the department became a section of the Accounting department under the jurisdiction of **P. G. Pollard,** auditor. Russell joined Prairie Oil and Gas Company at Independence, Kansas, in 1929, as a general accounting clerk. He was transferred to Tulsa in 1932. In 1951 he became assistant head of the IBM Computing section of Sinclair's Accounting department, and in 1955, was named head of the section.

•

Dr. Theodore E. Allen was appointed associate medical director of **Socony Mobil Oil Company.** Dr. Allen came to Socony Mobil from the Arabian American Oil Company, Aramco, where he has been associate medical director.

•

George W. Price, Jr., geologist in the Lafayette district, for Sohio Petroleum Company was transferred to the Gulf Coast division office. In this position he retains the title of junior geologist and reports directly to **T. C. Danie,** staff assistant to the division exploration manager.

•

Lloyd E. Lundahl has been named chief engineer and assistant maintenance superintendent for **Great Northern Oil Company,** Pine Bend, Minn. For the past two years Lundahl was assistant chief engineer in charge of design and construction of plant facilities for the Grace Chemical Company, Memphis. Previously he was in

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Rainbo Service .....Main 4-3596
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C. A. White.....EMpire 5-3833
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C. A. White.....919
BEAUMONT, TEXAS
ASEE Co.....TE 5-7046
KILGORE, TEXAS
B. M. Davis.....5541
WHITTIER, CALIFORNIA
Kline Wire Line Co.....OX 3-2731

2 GREAT NAMES ARE JOINED!

SEE PAGES 204-205

the Refinery Engineering and Construction division of Bechtel Corporation of San Francisco and the Shell Chemical Corporation of Houston.

•

Charles L. Hughes was recently appointed supervisor of the Personnel and Industrial Relations department of **Independent Exploration Company.** He will be responsible for formulating training programs and personnel procedures. Also, he will analyze and improve the management-employe relationship and augment management thinking with his training in these fields.

Charles L. Hughes

•

W. P. (Bill) Swearingen, formerly vice president in charge of drilling and production operations of **Gulf Coast Leaseholds, Inc.,** of Houston has opened offices at 538 Texas National Bank Building, Houston, as a consulting petroleum engineer, specializing in supervision of drilling, workovers, and production problems. Prior to service with Gulf Coast, he was employed by The Texas Company Production department in south Louisiana for 11 years as a petroleum engineer, during which time he served as chief engineer at the Erath Gas Cycling Project and as chief engineer of the Harvey district, New Orleans.

•

Darrell E. Smith, district geophysicist for **Stanolind Oil and Gas Company,** has been transferred to the company's District Exploration office in Salt Lake City. Employed as a junior geophysicist on a Stanolind seismograph party in Wyoming in 1949, Smith rose through successive field assignments to party chief in 1952, serving in Montana, Nebraska, Oklahoma, Arkansas and Louisiana.

•

Sun Oil Company made appointments of new managers at five sales districts. They are **Emory M. Osgood** at River Rouge, Mich.; **David H. Durham** at Pittsburgh; **Richard H. Sterling** at Dayton; **Frederick Heerde,** at Louisville, Ky.; and **James Moor,** acting manager at Burlington, Vt. In addition, two other announcements were made. They are the appointments of **Robert H. Eastman,** formerly assistant manager of the TBA department, to manager of TBA Sales; and **William A. Romeiser,** previously industrial products manager at the company's River Rouge district, to manager of the Industrial Products division at the Middle Atlantic region. Osgood joined Sun in 1946 as a salesman at the Erie Sales district. He subsequently served as motor products manager, Pittsburgh, and district manager at Youngstown, Ohio. At River Rouge he succeeds **John K. McKee** whose new assignment will be announced in the near future. Succeeding Osgood at Pittsburgh is Durham, who joined Sun's marketing organization in 1938 at Newark. He has been motor products manager at Hackensack, N. J., and district manager at Huntington, W. Va., and Dayton, Ohio. Durham is being succeeded at Dayton by Sterling, formerly district manager at Louisville, who joined Sun at Detroit in 1946. Heerde, formerly manager at Burlington, Vt., will assume similar duties at Louisville. He joined the company in 1939 at Boston. He held various marketing positions before he was named manager at Burlington in 1954. Moor is taking over his first district managership. Prior to his appointment he was motor products manager at Boston.

•

Cities Service Oil Company's Southwestern Exploration division headquarters were moved from Fort Worth to Midland. The Fort Worth offices were closed on October 31. The change from Fort Worth will headquarter approximately 60 members of Cities Service's Land-Lease, Geological and Geophysical departments and staff attorneys in the Midland offices. **Frank Cooter** is southwestern division exploration manager. **R. S. Hunt** is division exploitation geologist.

•

John F. Tolleson has resigned from the active management of **Molasse Oil** to open his own offices as a consulting petroleum geologist. He will continue to be retained as a consultant to Molasse. **Raymond-Claude Foex** will be manager and **Bruno Muller** procurist of the company.

•

Thomas E. Monaghan

Thomas E. Monaghan has been named general counsel of **Standard Oil Company** (New Jersey) moving up from his current post as associate general counsel to succeed **E. F. Johnson,** who is retiring after 30 years service. Monaghan has been with the company since 1946.

•

Frank B. Odasz was promoted manager, Development and Control, of **Husky Oil Company.** Formerly assistant director, Technical Service, Odasz joined Husky in 1947, as research chemist. Prior to joining Husky, Odasz served as research assistant at the University of Michigan and research engineer for Parmelee Motor Fuel Company in New York City.

•

James L. Martin, Jr., assistant chief geologist for **Sinclair Oil & Gas Company** has been named chief geologist for the company. Martin joined Sinclair in 1943 and worked as a geologist at Tallahassee, Fla., for more than five years and as geologist and district geologist at Jackson, Miss., for a similar period. He was named division geologist at New Orleans in 1954, and was transferred to Tulsa as assistant chief geologist early in 1955. He worked for the Louisiana Geological Survey for three years prior to joining Sinclair.

•

The Vickers Petroleum Co., Inc., has announced two appointments in the firm's Exploration department. **Henry H. Fuqua** has been appointed as Kansas district geologist. **Dwight S. Ramsey** has been appointed as Panhandle district geologist. Both men will headquarter in the firm's new offices in the Union Center Building, Wichita, and will report to **E. C. Abrahamson,** Vickers division geologist. Fuqua was a subsurface geologist for Sinclair Oil and Gas Co. and was engaged in geological activity for that company in Kansas for the past two years. Previously to his association with Sinclair, Fuqua had wide

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DOC slurry will never set hard unless contacted by water. Therefore, in a well where the formation is producing oil and water, the DOC slurry can be pumped in place, the squeeze completed and the excess slurry reversed out with ease. The addition of the chemical dispersant, DOC-1, increases the amount of cement that can be mixed in a given volume of oil. This very high ratio of cement-to-oil mixture usually requires less squeeze pressure and less slurry volume than conventional water-cement slurry.

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The dispersant DOC-1 also controls the penetration of the water to give a more efficient displacement of the Diesel oil, thus producing a set cement of high density, high compressive strength and very low permeability. These qualities make DOC slurry a successful material for repairing corroded and leaking casing, shutting off channels, and to cure many lost circulation problems.

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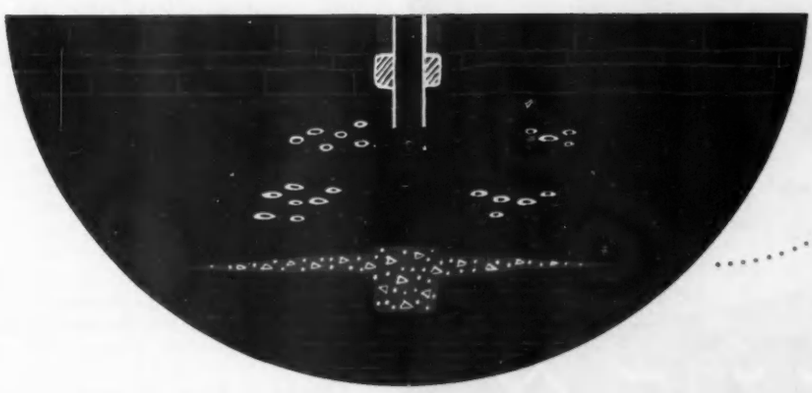

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experience in geophysical work in Kansas, Texas, Colorado, Wyoming and Nebraska. Ramsey was formerly associated with the Stanolind Oil and Gas Co. and for two years engaged in geological activity for the firm in the Panhandle area of Texas, Oklahoma, Colorado and Kansas. His geological background includes work in the states of Louisiana, Arkansas, Colorado and Montana.

Great Lakes Oil & Chemical Company announced that **E. W. Masters** has been appointed a director and consultant for the company. Masters, who has been associated with the oil business for many years, the last 30 years being with Shell Oil Company, will be actively engaged in the operations of the Great Lakes Company, and will be located at the company's offices, in Los Angeles.

DEATHS

Dr. Everett Lee DeGolyer, 70, was found dead December 14 in his office in Dallas. For more than 25 years he had been active in petroleum exploration and was rated as one of the world's leading petroleum geologists. In 1914 he accepted the job of consultant for the Mexican Eagle Oil Company. He went to London in 1918 to sell Mexican Eagle to Shell Oil Company, and the Amerada Petroleum Corporation emerged from the profits of this transaction. The Geophysical Research Corporation was established as an outgrowth of Amerada. DeGolyer opened offices in Dallas as an appraiser of oil properties with Lewis W. MacNaughton in 1932. His literary interests also led him to be chairman of the board of the Saturday Review of Literature.

Morris Miller Slotnick, 54, geophysical consultant with Standard-Vacuum Oil Company and well known research mathematician and geophysical interpreter, died in Dallas. He was chief mathematician for Humble Oil & Refining Company in Houston from 1936 to 1954.

Bobby Manziel, 59, well-known operator in East Texas and oil partner of Jack Dempsey, died November 9 in a Tyler, Texas, hospital. He was credited with discovering the Hawkins pool as well as with other successes in the East Texas trend.

Dallas E. Legan, 64, died November 25 in Chicago. He was division manager of production for Tidewater Oil Company.

Hoyt F. White, Sr., 75, retired oil man died October 22.

Captain Gaile E. Lindley, 55, Standard Oil Company of California executive, died September 24. At the time of his death he was president of California Transport Corp. and California Tanker Co., both subsidiaries of Standard. During World War II he served with the Navy and was a member of the Army-Navy Petroleum Board.

John L. Steele, 59, owner of the Steele Drilling Co., died September 27 in Denver. He was credited with the discovery of the Glenrock pool south of Casper.

David S. Faulkner, 70, retired vice president of The National Supply Co., died October 11, 1956 in Los Angeles.

Ross Chenault died October 5. For many years he was employed by the Trinidad Oil Company in Trinidad before coming to New York to become associated with D. T. (Mickey) O'Connor, export representative for a group of oil field specialty equipment manufacturers. Ross was also a member of the New York chapter of Nomads.

Roger S. Williams, 54, of the Aviation Trade department of Standard-Vacuum Oil Company in New York, died May 24 at the age of 55. He began his employment with Standard Oil Company (New Jersey) in 1923 and filled several foreign posts for Stanvac during his career.

Ernest Raymond Love, 61, vice president and treasurer of A. D. Rushing, Inc., Los Angeles oil well drilling contractors died recently while on a vacation tour of Great Britain and the Continent.

William A. Gresh, 50, died October 29. He had been with the Warner Lewis Company 12 years, serving mostly as a mechanical engineer.

Charles F. Frey, 73, died in Clarksdale, Miss., recently. Frey worked 31 years for The Texas Company as efficiency inspector, purchasing agent and materials supervisor, retiring in 1947 to practice consulting in Fort Worth, Texas. During the Korean emergency he served the Materials and Production divisions of the Petroleum Administration for Defense in Washington, D. C., as an analyst.

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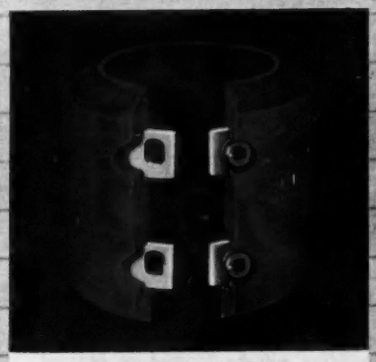
Use Safe-Loks at top of string

Use "Stretch-Ons" below Safe-Loks to bottom of casing



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STRETCH•ON

PB PROTECTORS

Two different types of PB drill pipe and casing protectors are in use today. One is the popular PB "Stretch-On" which has been the favorite of the oil patch for years. The other is the relatively new PB Safe-Lok Protector which drilling crews can install or remove in seconds. These two protectors are natural partners in casing protection. Here's how this combination benefits you:

Safe-Loks are *time and money savers* at the top of your drilling string. Here their instantly removable and replaceable feature eliminates the laying down and picking up of rubbered pipe. You simply *remove* Safe-Loks (based on estimated bit footage) as pipe comes out of the hole, providing unrubbered pipe in the derrick for make-up behind your new bit.

You eliminate three time-wasting operations: (1) unnecessary transfer of rubbered pipe from derrick to pipe rack; (2) the handling of unrubbered singles from the rack for bit make-up; and (3) the return of rubbered pipe from the pipe rack for use within casing. Pipe is handled in *stand lengths in the derrick*. Safe-Loks are quickly replaced on unrubbered stands at the top of the string as you go back in the hole.

PB "Stretch-On" Protectors are used to provide protection on all pipe where protector removal and re-installation is not a factor.

Use this new money-saving PB protector combination on your longer strings. And use PB Safe-Loks exclusively on all shallow drilling.

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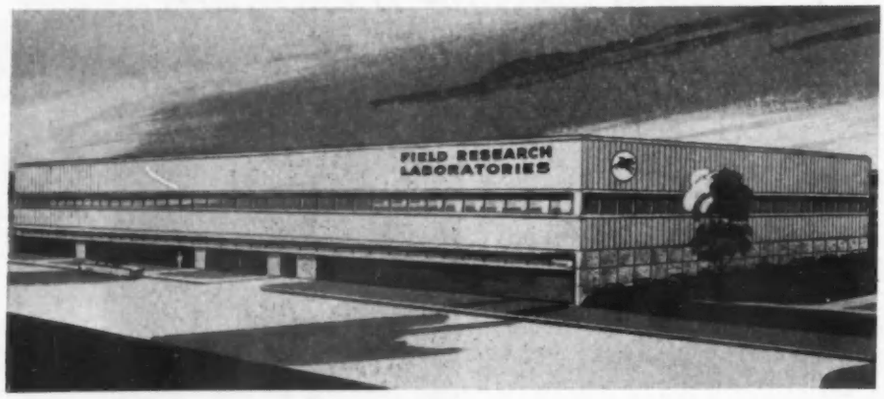
Companies in the News



Magnolia to Build Laboratory

Construction on a laboratory building for Magnolia Petroleum Company began last September. The new building will be located at Magnolia's Field Research Laboratories near Dallas at Duncanville. Specially designed for research purposes, the one-story structure will house 21 separate laboratories and 34 offices. The Field Research Lab's library and its digital computer will be moved into the new building. The basement of the building will furnish space for an instruments shop, an electronics shop and a photography processing room. The new building will provide room for new instruments and will replace small temporary buildings put up during World War II.

THE ACE-HI DRILLING CO. has been formed with offices in the Jenkins building, Tulsa, for the purpose of providing complete shot-hole and geophysical service to the oil industry. Officials of the new company include **George W. Reed**, president, **Walter H. McKenzie**, vice president in charge of operations, **John S. Carlson**, secretary, and **William B. Berard**, assistant secretary and treasurer.

GENERAL PETROLEUM CORPORATION concluded negotiations with Santa Paula y Saticoy Oil Company, San Francisco, to purchase the latter's mineral interest in approximately 6300 acres in Ventura County, Calif. Purchase price was not disclosed. The acreage is under lease to various operators, including Humble Oil Refining Company, Richfield Oil Corporation, Shell Oil Company, The Superior Oil Company, Union Oil Company of California, Western Gulf Oil Company and General Petroleum. Production has been developed on two of these properties and four additional wells are currently drilling. Property includes town lots in Saticoy and Santa Paula and various scattered properties outside these communities.

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JOHNSON RANCH ROYALTY COMPANY, INC., 91 percent owned by **MAGNA OIL CORPORATION**, and **CHARTA OIL CORPORATION**, have approved a merger of Johnson and Charta at special stockholders' meetings of the two companies. Johnson shares will be exchanged for those of Charta on a one-for-five basis. The merger will add an additional working interest in 40 producing wells and 28,719 undeveloped acres of leaseholds, royalty, overriding royalty and mineral interests to the properties owned or controlled by Magna Oil Corporation. Johnson, control of which was acquired last May by Magna, has 5333 acres of producing minerals and approximately 2450 acres of non-producing minerals, on which there are 281 oil wells and 234 gas wells, primarily in Texas.

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What's Happening

AMONG INDUSTRY ASSOCIATIONS

Oklahoma Contractors Review Association Action

Constructive work of the American Association of Oilwell Drilling Contractors in furthering the goals of the entire oil drilling and producing industry, as well as its own membership, was reviewed by a panel of four speakers at the December meeting of the Central Oklahoma chapter, in Oklahoma City.

Introduced by program chairman W. R. Ewert, Kerr-McGee Oil Industries, Inc., the speakers were Jack H. Abernathy, AAODC president; Joseph M. Shelton, insurance consultant; Brad Mills, AAODC executive vice president; and Paul Cain, president of The Cain Organization, Inc., public relations counselors.

Chapter Chairman Gerald N. Eason, Fain-Porter Drilling Company, presided over the meeting, which was attended by 185 AAODC members and oil producer guests.

Abernathy devoted a major portion of his talk to the effect of oil imports on the drilling industry. Since the domestic producing industry drills about one well per $120,000 of crude oil sales, he said, "if you import $120,000 worth of oil it means in effect that you drill one less oil well in the U. S."

Pointing out that the AAODC is working closely with the President's Committee on Fuel Resources in an effort to balance imported and domestic production, Abernathy said that prior to the event of the Suez situation, "we were approaching an equitable agreement on the handling of the sensitive question. However, the trouble in the Middle East has thrown all this carefully planned work out the window. We will have to start again when the trouble quiets down."

Consultant Shelton called specific attention to the Insurance Committee's activity in delaying moves toward a shift of jurisdiction of workmen's compensation laws from state to federal bodies. Shelton pointed out that total savings in Texas and Oklahoma through AAODC efforts to reduce workmen's compensation rates have been approximately $6,500,000 since 1952. "On a basis of 1000 rigs operating, these efforts reflect a saving over the period of $6,500 per rig—certainly a highly significant saving."

Touching on AAODC activities and objectives, Mills said contractors now drill 93 percent of all oil wells completed annually in the U. S., and oil companies look to the contractors for efficient performance. He pointed out that contractors have improved the drilling rate of penetration by 90 percent since 1941.

Oklahoma's Gary to Head 1957 IOCC as Chairman

Oklahoma Governor Raymond Gary will be chairman of the Interstate Oil Compact Commission for 1957. This was announced at the IOCC's annual meeting last December in Miami Beach.

The Oklahoma chief executive will have Clarence T. Smith, Flora, Ill., and J. P. Jones, Bradford, Penn., as first and second vice chairmen, respectively.

Judge Earl Foster was again selected executive secretary, an office he has held since December, 1944.

At a banquet at the Fontainebleau Hotel, retiring chairman John F. Simms, governor of New Mexico, was presented with a plaque on behalf of the Compact member states for the "outstanding and meritorious work he has done as chairman."

Three states were officially made members of the Executive Committee. They are Montana, Pennsylvania and Wyoming.

The Executive Committee is now composed of the governors or their representatives from the three states above and the following: Arkansas, Colorado, Illinois, Kansas, Louisiana, New Mexico, Oklahoma and Texas.

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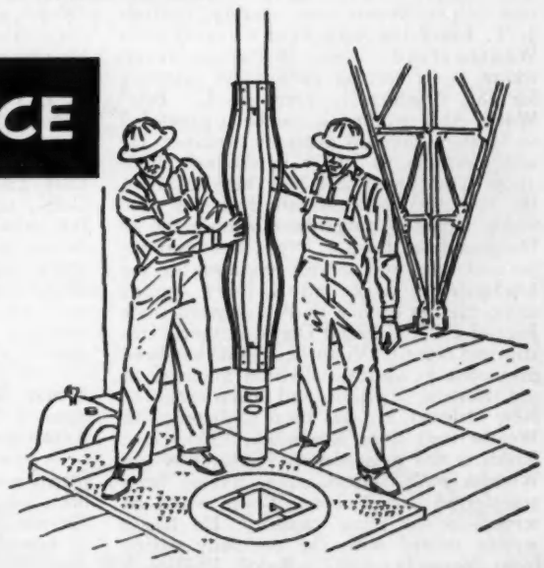

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What's Happening

AMONG SERVICE AND SUPPLY MEN

Addison Love

J. T. Liner

R. L. Wood

Clyde Baumgardner

Garland Diggs

Ralph Phillips

Gene Smith

Hal Waller

A. F. Canada

Ernest G. Unrath

F. W. Bremmer

Joseph R. Mahan

Weatherford Oil Tool Co., Inc., has made six promotions and transfers and one addition to the field service staff. **Addison Love** recently joined Weatherford as chief engineer and will be in charge of production research and design, present production improvements and quality control. **J. T. Liner** has been transferred from Weatherford, Texas, to Pampa, Texas, where he is serving as division manager for the Panhandle area. **R. L. "Bob" Wood,** Abilene, Texas, has been promoted to Western division assistant manager. He will continue to reside in Abilene, handling West Texas and New Mexico areas. He has been with Weatherford for nine years. **Clyde Baumgardner,** transferred to Houston from Casper, Wyo., has been appointed sales and service engineer for the headquarters Area and Export department. He has been with Weatherford since July of 1952. **Garland Diggs,** formerly district manager of Victoria, Texas, has been promoted to assistant division manager of the Eastern division and transferred to New Orleans. He has been affiliated with Weatherford since November, 1955. Gene Smith is the new district manager of the Wichita Falls, Texas, area, having been transferred from Nocona, Texas, where he served in the same capacity. He has a service record with the company dating from November, 1952. **Ralph Phillips** is a new addition to Weatherford's team, and is stationed at and services the surrounding territory of Fort Morgan, Colo.

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Truscon Steel Division, Republic Steel, Youngstown, Ohio, announced the appointment of **Hal Waller** as district sales manager of the Houston office. He succeeds **J. D. Kirkwood** who has been transferred to the main office in Youngstown, Ohio, as manager of sales, steel joist and tower products. He joined the Truscon sales organization in 1938 and has served as sales representative in the New York, Pittsburgh, Houston and Portland sales offices. He was appointed district sales manager of the Salt Lake City office in 1948. In March of 1953 he was appointed district sales manager of the San Francisco sales office, a position he held until his present appointment.

•

A. F. Canada has been elected vice president in charge of sales, Centrifugal Pumps division, of Pacific Pumps, Inc. Canada was formerly centrifugal pumps sales manager of the Huntington Park, Calif., company. He has been active in the sales and engineering of centrifugal pumps since 1929. He joined Pacific in 1945, serving as manager of the Tulsa office and mid-continent regional manager until 1954, when he was appointed sales manager of the Centrifugal Pumps division.

•

Ernest G. Unrath, formerly works manager of The National Supply Company's Ambridge, Penn., seamless pipe mill, has been elected to the position of vice president, manufacturing. **F. W. Bremmer** has been elected vice president, engineering. He was formerly vice president in charge of manufacturing. **Joseph R. Mahan,** formerly director of engineering, has been made director of research and engineering, which has been established as a separate function of the company, reporting directly to the president. Unrath joined the Ambridge plant in 1931, and was active in new product development before entering the Hot Mill department as an assistant superintendent. In 1949, he was made works manager at Ambridge. Bremmer joined the company's Ambridge plant in 1924. He rose from hot mill foreman to plant metallurgist and assistant superintendent of the hot mills. In 1940 he was appointed works manager of National Supply's Etna, Penn., plant, and in 1948, works manager of the Ambridge plant. He was elected vice president in charge of manufacturing for the entire company in 1949. Mahan joined National Supply at its Torrance, Calif., plant in 1922. He later was transferred to the company's Toledo, Ohio, plant where he became district engineer. In 1944, he became director of engineering, which position he has held until his present appointment.

•

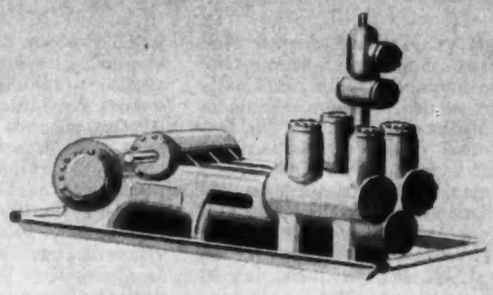
Fred H. Tinsley has been named export manager for **Franks Division, Cabot Shops, Inc.** He was promoted from ordnance plant superintendent of Cabot Shops in Pampa, Texas. He has been with the company 19 years. With headquarters in the Franks division Tulsa office, Tinsley will be in charge of sales and service for Franks pulling units and Franks drilling rigs in the international market.

•

Arthur J. Connell has been elected a vice president of **Stone and Webster Engineering Corporation.** Connell has been with Stone and Webster since 1951. He will work in the petrochemical field in his new post.

•

Mid-Continent Supply Company recently announced personnel changes affecting 27 men in the company's operations in the U. S., Canada and South America. **J. P. Jones** has been moved to the firm's Fort Worth headquarters and named assistant to general manager of sales. **W. A. Sellers** recently assumed duties as assistant to general division manager, Jones was district manager at Houston and Sellers district manager at Odessa, Texas, before they were promoted to new positions at



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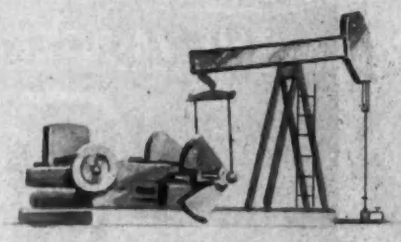

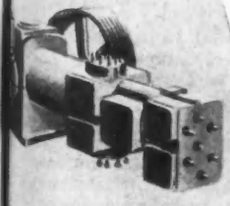

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Fort Worth. **R. S. Weilman**, former New Orleans district manager, is new Gulf Coast division manager, and **E. E. Campbell** has been named division machinery manager at Midland, Texas. **W. M. Day** recently assumed duties as assistant division sales manager at New Orleans.

Mid-Continent formed three new districts and made nine district personnel changes to increase service in a number of oil-active areas. The Odessa district has been divided. **J. W. Eastham**, former Brownfield district manager, has been named Odessa district manager, and **M. L. Hancock** manages the new Hobbs, N. M., district. **Bill Thornton** has been placed in charge of the Abilene, Texas, district and **A. L. Murry** the Wichita Falls, Texas, district. Other men promoted to district manager are **R. E. Dunn** at Wichita, Kansas; **T. R. Fleeman** at Brownfield; and **J. O. Ramsey** at New Orleans. Included also in Mid-Continent's district expansion are the promotions of **R. W. McDaniel** to district machinery manager at Edmonton, Alberta, Canada; **W. R. Shuffield** to district sales representative at New Iberia; and **B. J. Shipman** to district sales representative at Oklahoma City.

R. F. Timmons has been moved from Denver to Mid-Continent's Export division at New York as sales representative. In Caracas, **J. W. Davis** has assumed new duties as Venezuelan manager. **B. J. Dickey** recently moved from Newcastle to Estevan, Saskatchewan, Canada, where he is heading operations of Mid-Continent's mobile field supply store. Construction is scheduled to begin soon on a permanent field supply store at the Estevan location. Nine men have been made manager of field supply stores. **F. C. Burkett** was named store manager at Wichita Falls, Texas; **J. R. Cunningham** at Magnolia, Ark.; **R. H. Goodwin** at Bowie, Texas; **F. D. Groves**, Eunice, N. M.; **L. O. Lilly**, Sundown, Texas; **R. H. Martin**, Hobbs; **H. E. Rydell**, Andrews, Texas; **R. E. Shannon** at Great Bend, Kansas; and **R. R. Thomson** at Plainville, Kansas.

Harry Franke

A. O. Quinn

Harry Franke has been promoted to production manager and **A. O. Quinn** to chief engineer of **Aero Service Corporation**, Philadelphia. Franke, who joined Aero's staff in 1937, formerly managed the company's photographic laboratory. In his new position, he will be responsible for scheduling and performance of work under customers' contracts and orders. He is credited with considerable work in the field of high resolution photography and methods and more specifically in photography as applied to photogrammetry. Before association with Aero, Franke was employed by Tesco Optical Laboratory as assistant plant superintendent. Quinn has been affiliated with Aero Service since 1950. Before his appointment to chief engineer, he headed Aero's engineering and field surveys divisions. His new duties will include formation of a technical department charged with planning, estimating and quality control of the company's services. He will also supervise and develop new methods and products while acting in the capacity of top consultant to Aero's clients in the engineering field. Prior to joining Aero, Quinn served as associate professor of photogrammetry at Syracuse University.

•

Baroid Division, National Lead Company, has announced six key administrational appointments in line with the growth of its Technical Service and Research departments. **Dr. J. W. Jordan** has been appointed technical director of all Baroid laboratory activities. These laboratories were formerly designated as Sales and Service and Research and Development. Dr. Jordan will also continue his over-all supervision of the Pilot Plant, Technical Consultants, and Fellowships. **R. E. Offeman** has been named associate technical director and will assist Dr. Jordan in performance of his duties. Offeman will be principally concerned with special projects and surveys, new products and liaison with other departments. **E. E. Huebotter** has been appointed assistant technical director for drilling muds. He will aid Dr. Jordan in the over-all supervision of the Drilling Mud Laboratories. **Jay P. Simpson** has been made supervisor of the Drilling Mud Laboratories. These laboratories will conduct research and development work, field service on drilling muds and be responsible for the laboratory training of mud engineers. **Dr. R. E. Fariss** is appointed supervisor of the Bentone Laboratories, which conduct research and development and field service on Bentones and allied products. **Dr. J. L. McAtee** has been named

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supervisor of the Technical Service laboratories.

•

D. Mitchell

Frank Steen

W. L. Voegeli

W. J. Klein

Dale Mitchell, well-known Brooklyn Dodger baseball outfielder, has been named special sales representative for **Associated Oil Field Rentals,** Houston. Mitchell was the last man to face **Don Larsen,** when the latter pitched his no-hit no-run game in the recent World Series.

•

Southern Geophysical Company has announced the appointment of **Frank Steen** as assistant to the president in charge of public relations. Steen will headquarter in the Fort Worth home offices. Steen has had more than 10 years' experience with oil industry service and supply companies. Most recently, he represented Camco, Inc., in the Gulf Coast area for eight years. He had previously been in the sales organization of Tube-Kote, Inc.

•

W. J. Klein was appointed vice president and director of sales, and **W. L. Voegeli** was appointed general sales manager, Tractor group, **Allis-Chalmers Manufacturing Company.** The three divisions of the Tractor group are Farm Equipment, Construction Machinery and Buda, which manufactures engines and material handling equipment. Klein has been vice president and general sales manager, Tractor group, while Voegeli has been assistant director of engineering. Klein became affiliated with Allis-Chalmers in 1928, starting as a salesman at the Sioux Falls branch. Voegeli started with Allis-Chalmers at the Wichita branch as a serviceman in 1935.

•

John J. O'Connell has been appointed marketing vice president of **Amoco Chemicals Corporation,** which will be formed before the end of the year through consolidation of three chemical affiliates of Standard Oil Company (Indiana). O'Connell has joined the Chicago offices of **Jay H. Forrester,** Amoco Chemicals president elect. **Dr. John W. Bertetti,** who will be vice president in charge of manufacturing, has joined the Chicago offices. O'Connell has been manager of the Solvents department for Shell Chemical Corporation at New York City, and has been associated with Shell since 1946. He held various sales and marketing positions in the chemical field with Shell, both in the far west and in the New York area. He was with American Cyanamid Corporation before the war, starting at the Stamford, Conn., research laboratory and advancing to positions in sales promotion and development in the head office in New York City.

Dr. Bertetti since 1952 had been general manager of manufacturing and since 1954 a director of Pan-Am Southern Corporation, a Standard Oil Company (Indiana) affiliate, at New Orleans, La. He joined the Standard Oil research department in 1934, and in 1936 transferred to Pan American Refining Corporation and became research group leader. In 1942 Dr. Bertetti became associated with Root Petroleum and in 1950, shortly after it became part of Pan-Am Southern, he was promoted to refinery manager at El Dorado, Ark. He transferred to New Orleans in 1951 and until 1952 was assistant general manager of manufacturing.

•

Charles D. Wagner retired as president of **Wagner-Morehouse, Inc.,** of Los Angeles, Cal. **Harry C. Morehouse** was recently elected to the office of president to succeed him. Founder of Wagner Sales & Service, Inc., in 1936, later reorganized as Wagner-Morehouse, Inc., when Morehouse became associated with him, Wagner spent most of his business life in the manufacturing division of the oil equipment industry. At various periods of his career he was associated with such concerns as Fairbanks Morse Co., Axelson Manufacturing Company and was one of the early officers and director of Emsco Derrick & Equipment Company.

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Frederick M. Mayer To Head Youngstown's Continental-Emsco

J. L. Mauthe, chairman of The Youngstown Sheet and Tube Company, Youngstown, Ohio, announced that effective January 1, 1957, its Continental Supply Company and Emsco Manufacturing Company divisions were consolidated into one division, to be known as Continental-Emsco Company. General offices are in Texas.

Frederick M. Mayer, president of Continental, and recently elected a vice president of The Youngstown Sheet and Tube Company, will be president of the new company.

F. M. Mayer

Simultaneously, it was announced by Mayer that in the combined Continental-Emsco Company, William T. Powell will be executive vice president in charge of manufacturing and engineering, and Frank I. Brinegar will be executive vice president in charge of distribution. The following vice presidents of Emsco and Continental, W. C. Kinder, D. M. Bailey and Raleigh Hortenstine, Jr., will continue as such in the new company. In addition, J. A. Mussler has been appointed a vice president, and will be in charge of all tubular sales (steel, aluminum and plastic), as well as all pipe line equipment. Kinder will be in charge of machinery and allied sales.

Effective last October 31, The Youngstown Sheet and Tube Company of Youngstown, Ohio, the principal stockholder of Emsco Manufacturing Company of Los Angeles, Calif., purchased all of Emsco's properties, assets and rights and assumed all the obligations and liabilities of the company under a plan of reorganization approved by Emsco's stockholders.

F. I. Brinegar

W. T. Powell

At that time all business conducted by Emsco Manufacturing Company was to be conducted in the name of Emsco Manufacturing Company, a division of The Youngstown Sheet and Tube Company. The Johnston Pump Company division of Emsco Manufacturing Company at Pasadena, Calif., was to continue its operations as Johnston Pump Company, a division of The Youngstown Sheet and Tube Company.

No change in sales, operating or personnel practices was contemplated by The Youngstown Sheet and Tube Company at either the Emsco or the Johnston Pump Company divisions. The businesses were to operate in the same manner as prior to the reorganization.

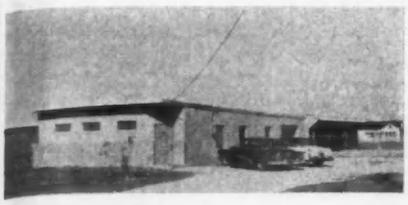
Core Laboratories planned Oklahoma City building.

Core Begins Construction On Oklahoma City Plant

Core Laboratories, Inc., has announced the beginning of construction on a new Oklahoma City building at the corner of North Young's Blvd. and Nw 39th Street, adjacent to U. S. Highway 66 Cut-off. Present operations are located at 710 North Broadway.

Officials of the petroleum reservoir engineering firm report that the $115,000 laboratory and office building will be the largest and most modern commercial facility of its type in the Mid-Continent area. An unusual architectural innovation will be the use of oil well cores taken from wells drilled in Oklahoma, to form one complete wall of the reception room. It will be called "The Anadarko Basin Wall," with cores arranged according to geologic age.

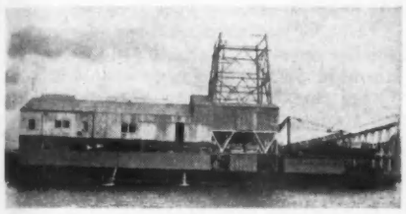
Directed by J. W. Barbour, Jr., district manager and vice president, the new Oklahoma City installation will continue to serve as a base point for other labs located in Ardmore, Tulsa, Bartlesville, Arkansas City, Great Bend, Liberal and Wichita Falls.



New Plant Facilities Announced By Corrosion Rectifying Company

It has been announced by Wayne A. Johnson, president, that the newly expanded facilities of the Corrosion Rectifying Company have been moved. Their new address is 5310 Ashbrook, Bellaire, Texas.

Their activities include a complete cathodic protection engineering and installation service for the petroleum industry. Recently they developed Electronics International Incorporated to design and manufacture the electronic equipment used in corrosion prevention work. This will provide closer control over the equipment provided with their installations and insure the best possible results.



Levingston's drilling barge *Timbalier Bay* was built for the Brewster-Bartle Drilling Company.

Levingston Shipbuilding Delivers 3 Major Oil Equipment Pieces

The Levingston Shipbuilding Company's Orange shipyard delivered a record amount of barges and equipment within a three-day period. A submersible drilling barge 180 feet long, 48 feet wide by 12 feet deep; one drilling tender barge 180 feet long, 70 feet wide by 11 feet 3 inches deep; and one offshore drilling platform 54 feet by 100 feet standing 55 feet high, left the Levingston docks for destination "Oil."

The drilling barge Timbalier Bay, a submersible unit, constructed for the Brewster-Bartle Drilling Company, joins seven others built by Levingston for this company and will operate in the shallow bays along the Gulf Coast. Installed aboard were two 818 Oilwell mud pumps and one P-214 mud mixing pump driven by three Waukesha 900 horsepower engines with an Oilwell 96 drawworks and compound. This Drilling Barge is equipped with up-to-date safety features, in addition to comfortable air-conditioned quarters for 10 men. Its drilling equipment will permit drilling operations in the 18,000 to 20,000 feet range.

The offshore drilling platform constructed for the Magnolia Petroleum Company will be located in the Gulf of Mexico where it will operate in conjunction with a drilling tender in approximately 20 feet of water.

Core Lab Expansion Program Highlighted by Millionth Sample

Core Laboratories, Inc., Dallas, recently revealed that it has analyzed "The Golden Foot"—the one-millionth sample to be evaluated since the reservoir engineering firm was organized in 1936. Company

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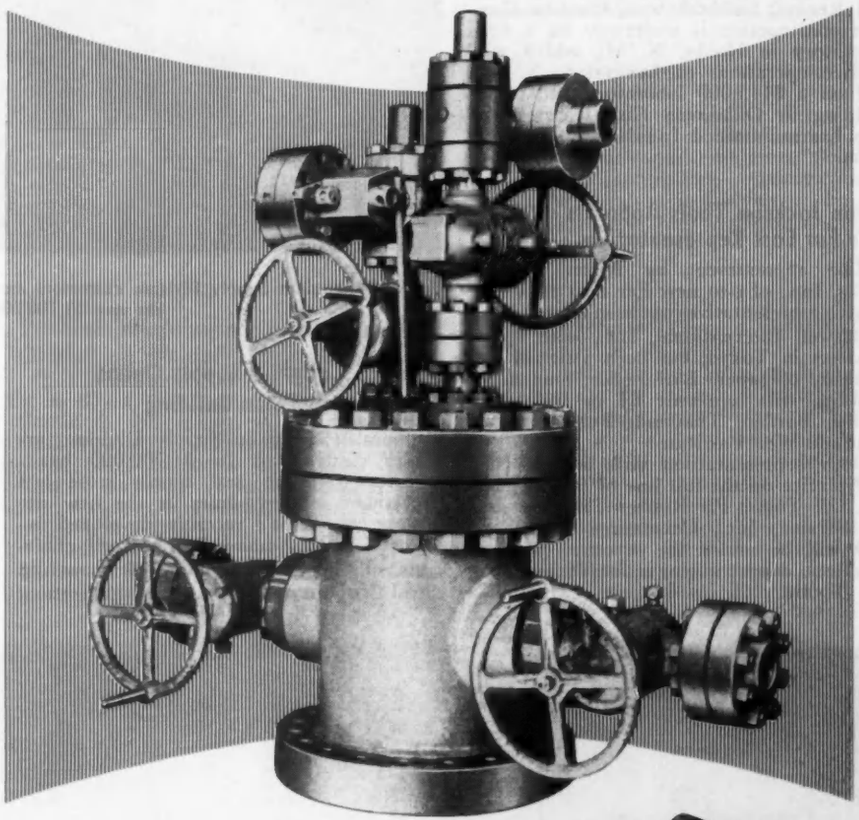
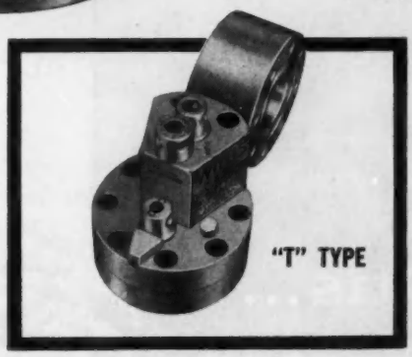


Simplify Dual Completions with **WILLIS** Rotary Adjustable Chokes



Willis Rotary Adjustable Chokes provide 6 different size choke inserts which are individually positioned in the line of flow by a fractional turn of the orifice—carrying disc... while under constant flow and high pressure. Simplicity of this uncomplicated Christmas tree (note deletion of wing valves) is accomplished by using a blank orifice in one of the 6 positions of the Willis Rotary Chokes for shut-in without closing the master valve.

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officials explained that, with 38 labs now operating on a 24-hour schedule, it was impossible to identify the specific circumstances under which the coveted goal was reached. However, John D. Wisenbaker, president, noted that the event occurred during Core Lab's greatest expansion period.

Since January, 1956, new laboratories have been opened at McAllen, Texas; Long Beach, Calif.; Kimball, Neb.; and Craig, Colo. Larger and improved facilities have been established in Midland, Texas; Shreveport, La.; Tyler, Texas; Wichita Falls, Texas; Farmington, N. M.; and Regina, Saskatchewan, Canada. Current construction is underway on a new laboratory in Hobbs, N. M., which will replace operations in Lovington, N. M., and on a $115,000 laboratory and office building in Oklahoma City where Core Lab has maintained facilities for many years.

Byron Jackson Tools Appoints Two Far East Representatives

The appointment by Byron Jackson Tools, Inc., of two new Far East sales and service representatives has been announced.

Boswell International, Inc., with headquarters in Tokyo, has been assigned the territory of Japan. Earl Fuller, Singapore, Malaya, will represent BJ in Indonesia, British Borneo, Thailand, Burma, India, East and West Pakistan.

Both representatives will handle sales and service on the full line of Byron Jackson Oil Tools, PB Rubber Products and BJ Service, Inc., Cementing Equipment and will be under the direction of Earl M. Rees, export manager for Byron Jackson Tools.

Jones & Laughlin Supply Division customers make their purchases in the supply store area of the new $1,700,000 Tulsa building.

Jones & Laughlin Supply Opens $1.7 Million Tulsa Building

Jones & Laughlin Supply Division formally dedicated its $1,700,000 headquarters building and supply store last December in ceremonies at the new site in one of Tulsa's recently developed industrial areas. Admiral Ben Moreell, chairman of the board of Jones & Laughlin Steel Corporation, the parent organization, officially opened the building by cutting a strand of J&L wire rope.

Other speakers during the brief program were C. L. Austin, J&L's vice chairman of the board, Pittsburgh; John E. Timberlake, J&L's vice president, sales, Pittsburgh; Rainey Elliott, president, Jones & Laughlin Supply Division, Tulsa; and W. L. Wolfe, vice president, sales, Jones & Laughlin Supply Division, Tulsa.

The J&L Supply Division formerly occupied quarters on a 3½-acre site. The

Division's 300 general office employes moved into the new facilities last November. The site had been the company headquarters since June, 1926.

From its general office headquarters in Tulsa, the Division now directs the operations of 27 district and sales offices and 90 oil field supply stores in 17 states and three provinces in Canada. These stores and offices serve the petroleum industry from the Rocky Mountain Divide to the Atlantic Coast, and from the Gulf of Mexico to the oil fields of Canada.

The new building was designed by Black and West, Architects, Tulsa, with H. Lyman Cauvel, consulting engineer, and under the direction of Rainey Elliott, president, and L. G. Sutter, general manager-administrative services, of the Supply division. The general contractor was Tulsa Rig, Reel and Manufacturing Company. It also houses a central warehouse and a supply store. It is located on a 10-acre tract which also includes a 240-car parking lot and a pipe storage area.

The one-story office area has 50,500 square feet, with metal movable partitions, allowing future changes to be made without prohibitive cost, confusion, or loss of time. The west offices are protected from the sun by pre-cast concrete louvers, and the south offices by canopy and porcelain enamel sun shields between windows, perpendicular to the building. The exterior walls are face brick with painted lightweight block back-up. The block, with insulation, is also used for sound proof, permanent partitions around toilets, tabulation room, kitchen, etc. The metal perforated ceiling can be cleaned at frequent intervals throughout the life of the building.

Kimray's addition to their machining and assembly facilities in Oklahoma City.

Garman O. Kimmell Heads Oklahoma City Kimray

Kimray, Inc., Oklahoma City manufacturer of oil field controls, valves and specialties has recently completed an expansion program which has more than doubled their machining and assembly facilities. The new building in Oklahoma City contains, in addition to the assembly section, an electronics laboratory, drafting room, increased office space and garage.

Kimray, Inc., is headed by Garman O. Kimmell, president of the firm. These products include gas regulators, floatless liquid level controllers, separator and treater dump valves, motor valves, temperature controllers and miscellaneous specialty items.

T I Aluminium Improves Methods Of Making Welded Tubing, Alloys

T I Aluminium Ltd., is now producing at its South Wales plant welded tubing in aluminum and certain of its alloys by a method which permits not only very rapid production, but also a high degree of accuracy, both as regards diameter and concentricity. The diameter can be controlled within 0.004 inch.

Welded tubes of up to 4-inches in diameter can be manufactured at the present time but the range will be extended as the demand warrants. There is no manufacturing limitation on length.

The tubing is made from sheet shaped on rollers into the desired cylindrical form and automatically seam welded. There is no trace of a weld bead either inside or outside, and in fact the surface condition is so good that it is not easy to detect where the weld has taken place.

As a regular routine all pipes are hydrostatically tested to 350 lbs per square inch pressure. Bursting pressures are considerably higher, even up to 1200 psi.

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It was reported in the trade press recently that an operator in South Louisiana saved an average of 34 hours' rig time alone for each permanently-completed well. The tubing and wellhead are installed only once in a permanent completion — then the rig can be moved off. Perforating, testing, and placing the well on production are performed with wire line equipment at considerable savings over conventional methods. Heavy pipe-handling equipment normally used for workover operations is eliminated. And most significant about permanent completions is the number of *different* operations which can be performed *without a rig or workover unit:*

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Testing stringer sands • Dry-testing cement jobs with tubing and packer in place
Radioactivity logging through tubing • And many others — all of which reduce workover time and costs, provide safer operations, and make a better producer.

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Due to the recent death of one of the owners of Threeway Drilling Company we have decided to sell our rotary drilling rigs. We have two exceedingly well kept Bethlehem drilling rigs fully equipped for drilling in the Permian Basin. If interested please contact Mr. Charles I. Francis, Mellie Esperson Building, Houston, Texas, or Mr. J. K. Hazlip, Box 824, Midland, Texas.

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We have for quick sale quantity of Allison V-1710 engines and related parts. New — overhauled — low time. Prices on request.
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SCOUTING AGENCY
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185,000 ACRE RANCH Southwest Texas in Presidio and Brewster counties, 36 miles Rio Grande river frontage, 81,100 acres State mineral classified, leaving around 140,000 mineral acres . . . 600 miles sheep proof fence, wonderful improvements includes 7 houses, one almost a mansion, 10 line camps, 40 windmills, 150 miles water pipe lines, railroad loading pen on ranch, black tail deer, javelinas, and blue quail. Has been very dry past few years has run 45,000 sheep and goats, has $4.50 acre loan can be brought with very little cash per acre . . . ask for pictures . . . Landing strip.
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HELP WANTED

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PHONE: Drumright 569

J. B. Beaird Company Installs New Stress Relieving Oven

Installation of a $160,000 stress relieving furnace has been completed at the Shreveport plant of The J. B. Beaird Company, Inc., manufacturers of heavy steel products.

The addition of the huge furnace, which accommodates a vessel 12 feet in diameter, 78 feet long, in one heat, will enable Beaird to diversify its product market while increasing the strength and quality of its current production.

Conveniently located to connect with Beaird production lines, the gas-fired furnace will normally operate at 1100° to 1200° F., with a maximum range to 1400° F. Equipped with the latest control and recording instruments, the furnace, measures 80 feet long and 17 feet high at the door and is lined with nine inches of fire brick and one inch of insulating block. Heat is provided by 48 burners recessed at regular intervals along the sides.

Vessels will be introduced into the furnace by a furnace car made up of eight four-wheeled sections and chain driven by a 10 horsepower electric motor located outside the oven area. Furnace car tracks extend through the flank of the production bays to permit easier loading of vessels.

The stress relieving process heats vessels to slightly below the critical range, then cools slowly. Its application reduces internal stresses caused by rapid cooling, cold forming, rolling, bending or straightening or by welding. During its five-hour operating cycle, the furnace is pre-heated to 600° F. before the vessels are placed inside, then gradually increased in temperature to maximum heat necessary for a specified time and finally permitted to cool slowly.

HELP WANTED

PROJECTS ENGINEERS

Ambitious and energetic young Mechanical Engineers interested in design and research work on valves, fittings and associated products. Should have B.S.M.E. from good school plus three to ten years experience in a line related to the oil field. Excellent benefits and wonderful suburban location in a rapidly growing industrial area. This is your opportunity to grow with the oil industry's fastest growing company. Salary from $7,200 to $9,000 depending on experience and ability. In first letter please furnish complete resume, transcript of college credits and recent photo if available. Write Box 117-W World Oil, Houston, Texas.

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(Ages 30-38)

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Box 480
Dept. Y-82
New York 19, N.Y.

Magcobar Forms and Opens Louisiana Offshore Division

Formation and activation of a Louisiana Offshore division of the Drilling Mud department of Magnet Cove Barium Corporation has been announced. It is designed to give a more efficient service to Magcobar customers and is comprised of a group of specialized service engineers. It is in addition to existing service.

R. E. Hinchliffe

The Louisiana Offshore division is under R. E. "Rags" Hinchliffe, formerly Fort Worth division manager, and is headquartered at Lafayette, La. It consists of three new districts organized as follows: District No. 16 at Lake Charles, with Bill Glasspool, formerly district engineer at Lake Charles, as district manager; District No. 17 at Houma, with Robert L. Vannoy, formerly district engineer at Houma, as district manager; and District No. 19 at New Orleans, with Ken Begley, formerly service engineer at Lake Charles, as district manager. Drilling operations offshore Texas will continue to be serviced by the Texas Gulf Coast division under C. H. Sydow, Jr.

New Bucyrus-Erie Drill Plant To Be Built Near Richmond

A new $12 million drill manufacturing plant will be built near Richmond, Ind., by Bucyrus-Erie Company, according to an announcement from the company's home offices in South Milwaukee, Wis.

The new plant, which will be erected on a 148-acre site three miles west of downtown Richmond, will provide 300,000 square feet of floor space for the manufacture of drilling machines. The acreage for the plant site has been acquired and test drilling has been completed. The site fronts on U. S. Highway 40 on the south, and is served by the Pennsylvania Railroad's main line from St. Louis to New York at its northern boundary.

Work on construction of the plant will begin as soon as possible, a company spokesman said, with completion scheduled for late 1957 or early 1958. The new plant will employ about 1000 people.

Canada Fluor to Construct British American Oil Facilities

The Fluor Corporation of Canada has been awarded the engineering and construction of offsite facilities in conjunction with a new reformer and crude units being built by the British American Oil Company at its Clarkson, Ontario, refinery.

This work is now under way and is scheduled for completion in 1957. The cost of this project is approximately $4 million.

Wolverine Tube's Agents Open New Service Facilities

New offices and mill depot facilities have been opened in Denver to serve the customers of Wolverine Tube, Division of Calumet & Hecla, Inc.

These service facilities will stock copper water tube, refrigeration tube and automotive tube. It will be operated by W. G. Cline and Company, Western agent for Wolverine Tube.

2
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204-205

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Composite Catalog, Page 3369

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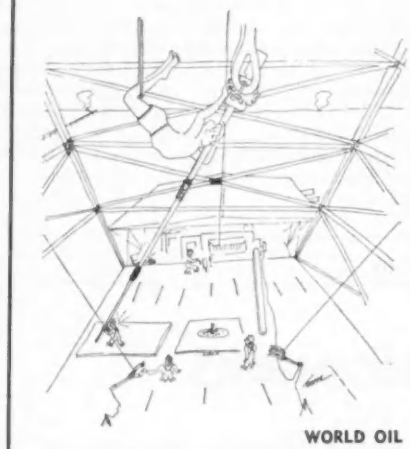

WORLD OIL

"I can't help it if he is the driller's nephew. Somehow I can't get myself to trust that derrickman."

Too Late

An old retired toolpusher took a room in a hotel and crawled wearily into bed. Just then, in bounced a girl-blonde, luscious and scantily clad.

"Oh," she cried, "I must have gotten in the wrong room."

"Yep," said he sadly, "Not only the wrong room, but you got here 40 years too late."

Germs or Wolves

"I like that dress you're wearing," complimented her swain. "But it's kind of long. Don't you know that long dresses pick up germs?"

"That may be," she agreed. "But you should see what the short ones pick up."

Your Own Fault!

He had been to an auction and bought a grandfather's clock and was carrying it home. Stumbling along, not being able to see too well over the top of it, he ran head-on into a drunk. Setting down the clock, he sneered, "Why in 'ell don't you watch where you're going?"

"Well, why in the 'ell don't you wear a wrish-wash, like everybody elsh?" queried the inebriate.

Discriminating Taste

A motor jockey was bragging that he was an expert on drinks, both soft and hard. One of his fellow workers walked over to a corner and returned with a bottle of liquid. "Take a swallow of this," he challenged, "and tell me what it is."

The windy guy took a swig and gasped, "That's gasoline!"

"I know," the other fellow agreed, "but is it premium or regular?"

A Woman's World

Life is cruel to men. When they're born, their mothers get compliments and flowers; when they get married the bride gets presents and publicity; and when they die, their wives get the insurance and the winters in Florida."

Overtime

Personnel manager interviewing applicant for job—

How long did you work in the other place?"

"Fifty-five years."

"How old are you?"

"Forty-five years."

"How could you work 55 years when you are only 45 years old?"

"Overtime."

Bigotry

First Steno: "How do you like your new boss?"

Second Steno: "Oh, he ain't so bad, only he's kinda bigoted."

"What d'ya mean, bigoted?"

"He thinks words can be spelled only one way."

Hysteria

"Psychologists say a hysterical girl is most efficiently quieted by a firm kiss."

"And do they say how to get them hysterical?"

Religious Conversion

He was a young minister and not afraid to mention his activity to an oldster, who had a local reputation as a Bible scholar. Finally the scholar promised, "If you will answer one question, I'll come to church."

"State your question," the minister accepted.

"Who was Cain's wife?" the old timer gleefully asked.

"My friend," the minister replied, "you

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McCullough Tracer Log Shows Where to Shut Off 300 B/D Water Entry

The accuracy of McCullough's Radiation Well Logger and the value of McCullough isotope injection methods and tracer logging techniques were recently demonstrated in this Rocky Mountain area well.

The well was originally completed as a good oil well. Shortly after completion water broke in and killed the oil production. Rate of water entry was 300 barrels per day. At the producing horizon 5½" O.D. 14.5 lb. casing had been cemented in 9" hole.

McCullough was called to run their Isotope Injector and logging instrument to attempt to locate the point of water entry. A channel was discovered in the cement behind the casing. Also, there was a channel from one interval of the sand, which was the producing horizon, to another interval which was water bearing. Depth of operation was between 4650' and 5072'.

The well was squeezed and is once again a good commercial producer. This tracer job required only 5½ hours to complete. Locating a point of water entry is often difficult if not impossible to do. In this instance, well conditions and the efficiency of McCullough instruments permitted the successful completion of the job.

HAVE YOU RECEIVED YOUR COPY?

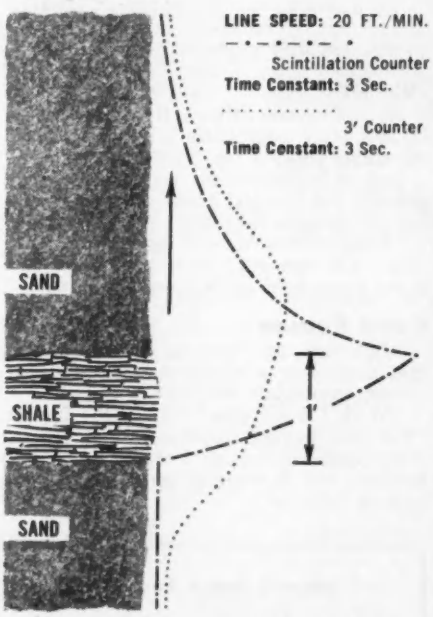
For Technical Paper on "Application of Radioactive Isotopes in Water Flood Operations"—Write McCullough Tool Company, 5820 South Alameda Street, Los Angeles 58, California.

Fifteen Borderline Wells Turned Into Profitable Producers

Precision Logging with McCullough's Scintillation Counter and Pin-Point Accuracy in Perforating Resulted in 645 B/D Increase in Production

Extra profits from only two days of increased production more than paid the entire costs of all McCullough Radiation Well Logging and Perforating Services according to the operator of this work-over project.

This company was producing fifteen borderline wells whose average production was 7 barrels of oil per well per day. Depths ranged from 3000 to 6000 feet. All wells had been electrically logged at the time of their original completion.



Illustrating the accurate definition obtained by McCullough's scintillation counter. Above shows the ideal response that would be obtained in measuring a thin bed with the scintillation counter and with a long counter. Note that, because of its short length, the scintillation counter exactly defines the boundaries of the thin bed, whereas the reading of the longer counter is an average of the radiation over the entire length of the counter.

Wells were re-logged with McCullough's Radiation Well Logger and it was found that there was as much as 17 feet of difference between the measurements obtained by the two types of logs. Also, several new zones were located that had been missed by the other logs.

Depending upon which perforating process would prove most effective for individual well conditions, the fifteen wells were shot with either McCullough M-3 Bullet Guns or Glass Jet Perforators.

Shooting the new zones disclosed by McCullough Logs and reperforating the old zones with McCullough depth corrections increased production to an average of 50 barrels of oil per day per well—a total gain of 645 barrels for the 15 wells. This was a highly profitable project.

McCullough's Radiation Well Logger, using the highly efficient scintillation counter, will give you the most informative, most accurate Gamma Ray and Neutron Logs available.

McCullough® TOOL COMPANY

Cable Address: MACTOOL

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HOUSTON
EDMONTON

(For more data on advertised products, use Readers' Service blue cards, last page this issue.)

will never be able to embrace religion until you stop bothering about other men's wives."

Just Like Dating

A pro was trying to explain the finer points of golf to a pretty beginner.

Pro: "The basic idea of golf is very simple. All you do is smack the pill, then walk."

Girl: "Oh, that's just like some of the dates I've been on."

Nickname

"I call my girl 'Carbon'," explained the electrical engineer, "because her resistance goes down when she gets warmed up."

Effie is sure we're goinna hit oil. She's making up a list of things she wants.

Real Trouble

A pair of newlyweds stepped into the hotel elevator.

"Hello, darling," murmured the pretty operator.

There was a chilly silence all the way up. But when they reached the floor the bride exploded:

"Who was that hussy?"

"Now don't you start anything," begged the groom. "I'm going to have enough trouble explaining you to her tomorrow."

Just One

At a telegraph office a little cutie swept in and after addressing a message, wrote the single word—"yes."

Just to be helpful the counter attendant pointed out the girl could send ten words for the same price.

"Thanks very much," smiled the darling, "I'll just send one 'yes.' If I said it ten times he'd think I was too anxious."

Good Reason

"Just tell me one good reason why you can't buy a car now," said the persistent automobile salesman.

"Well, I'll tell you," replied the farmer, "I'm still paying installments on the car I swapped for the car I traded in as part payment on the car I am two payments behind on now!"

First Man Out

Old Con: "How long you in for?"

New Con: "Ninety-nine years; how long you in for?"

"Seventy-five."

"Then you take the bed by the door; you'll be getting out first."

Women Drivers

A woman will look into a mirror anytime except when she is about to pull out of a parking space.

No Excuse

Two rather inebriated gentlemen were sitting on the curb.

"Watsh your wife gonna say about you shtaying out so late?" one spoke up.

"Don't have a wife," was the response.

"Well, then," asked the first one, "whatsha idea of staying out so late then?"

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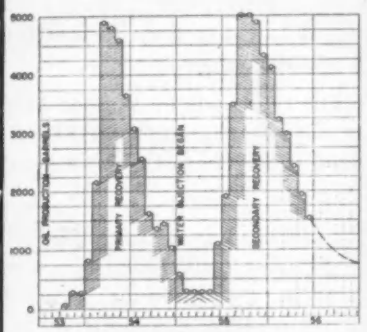

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Diesel Wrap-Around Base

A new type of wrap-around base and fuel tank combination has been developed for use with Caterpillar Diesel power units and electric sets, according to an announcement by Caterpillar Tractor Co.

The new bases have been designed for use with all cat engines and electric sets from the D311 through the D342. Models presently in production include extended and short base versions for Cat D337 (Series F) and Cat D326 (Series F) Engines, a short base model for the Cat D318 Engine and electric set bases for Cat D311 and D315 Diesel electric sets. Other models will be added in the near future.

The new bases will replace the steel channel models formerly used. The streamlined, space-saving design will feature a greater fuel capacity, lighter weight and studier, more rigid construction.

Primary advantage of the new bases is the ability to withstand the stresses and strains of skidding and dragging. Extreme strength and rigidity enable them to resist the bending, flexing and other distortions to which power units used in the field are frequently subjected.

An additional advantage of the new bases is the added fuel capacity made available by their design. All models of the new bases will have more capacity than was possible with the older tanks. Weight of the fuel tanks included in the new bases will be about the same as that of the channel-type bases alone.

(This item supplements Caterpillar Tractor Co. data on pages 1220-1223 of the Composite Catalog, 21st Edition.)

For more data, circle **No. E1** on Reader's Service Card, last page this issue.

Inorganic Zinc Coating

Only one coat of Dimetcote, a 100 percent inorganic zinc coating manufactured by Amercoat Corporation, cold galvanizes any steel surface. It is not a paint, contains no oils, resins or any other organic materials, yet it can be easily applied by conventional spray equipment. When Dimetcote is applied to steel, it bonds chemically as well as physically.

Dimetcote shows no visible change after more than 14 years exposure to the most severe weather conditions—sun, heat, fresh and salt water. It is insoluble in all solvents and petroleum products. It is highly abrasion resistant, but if abraded through to bare steel, an electro-chemical reaction between the zinc in the coating and the steel surface will cathodically prevent rusting.

Tanks and structures can be given the same protection that galvanizing affords, plus salt water resistance. Existing structures need not be dismantled and new structures can be coated either before or after erection. Only one coat of Dimetcote provides many years of protection to any sandblasted steel surface.

For more data, circle **No. E3** on Reader's Service Card, last page this issue.

Gasoline Engine Control

The new Foote Reverse-Reduction unit offers users of gasoline engines complete power control. It incorporates a 2:1 reduction, definite neutral, positive forward and reverse. The unit is fully enclosed in an oil-tight housing which is bolted to the engine crankcase, forming one integral power package. The manufacturer, J. B. Foote Foundry Company, Fredericktown, Ohio, will supply the unit separately or the unit and engine completely assembled, ready for use.

A feature of the unit is the double acting, precision machine tool clutch with over-center shift mechanism. This type of clutch permits the operator to shift instantly from forward to reverse or to neutral at any engine speed. Inching and braking are also easily accomplished with only finger-tip pressure on the shift lever.

Forward rotation is through a duplex roller chain drive. Reverse rotation is accomplished through spur gears. The unit is compact and sturdily built. Needle bearings and combination thrust and radial ball bearings are used throughout.

The first units have been designed for use with Briggs & Stratton engine Model 14. Adaptation to other engines of comparable sizes (5 horsepower at 3600 revolutions per minute) can be made through the use of adapter plates. The manufacturer states that additonal units are being designed for use with both smaller and larger air-cooled gasoline engines.

For more data, circle **No. E2** on Reader's Service Card, last page this issue.

Direct-Drive Plant

Two more direct-drive generating plants have been added to the Winco line of engine-generators manufactured by the Wincharger Corporation of Sioux City, Iowa. The two new Winco units, both designed to run at 1800 revolutions per minute, supplement the manufacturer's line which includes both 3600 rpm direct-coupled models and belt-connected styles.

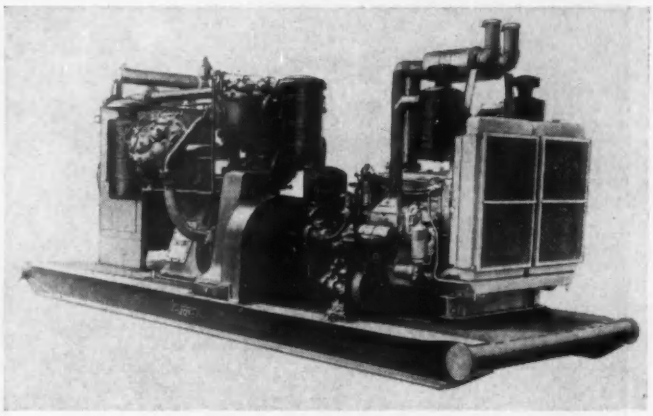
The Winco Series 2B23S4D is rated at 2000 watts, with plenty of intermittent overload capacity. Their 102B14S4D is rated at 1250 watts, also with plenty of margin for temporary overload. Both units are available with either manual or remote start, and in both series they can be supplied with a 2-wheeled dolly or with a carrying cradle. Also, in both series, the king-sized Winco generator is driven by a Briggs & Stratton engine.

For more data, circle **No. E4** on Reader's Service Card, last page this issue.

DRILLING

Portable Compressor Unit

A new semi-portable skid-mounted package compressor unit, specially-designed for air drilling, has been announced by Joy Manufacturing Company.



The new unit, the Joy AP-2, is a completely self-contained compressor plant, with two heavy-duty stationary type Joy compressors, powered by either diesel or natural gas engines. Output is rated at 1056 CFM for 125 psig, and 647 CFM for 250 psig, thus meeting demands for large volumes of air at low pressures, yet also supplying high pressure air at reduced volume.

In designing the AP-2, Joy engineers sought first-hand information from successful air drilling operators in active producing and exploratory fields, and built the unit specifically to meet the specialized needs of air drilling. Such practical features as instant portability and new remote control regulation are the result.

Mounted on a single heavy-duty oilfield type skid, the unit is entirely within road limits for highway transportation at any time, without the need for special permits. Piping-up at the drill site is all that's required to go to work.

Simple lever controls at the driller's console permit remote-control regulation of working pressures and complete compressor unloading without signals to an extra man, or loss of time traveling between the drill rig and the compressor unit. Regulation provides for automatic loading and unloading at maximum discharge pressure.

Two compressors are combined on the unit—a Joy WN-102 and a Joy WG-110. Both are heavy duty, two stage, double acting, water cooled, stationary type compressors. Power is furnished by either a GMC model 12103 diesel engine, or a Waukesha model 6-LRORBU, or a Climax model V-122 natural gas engine.

(This item supplements Joy Manufacturing Co. data on pages 385-468 of the Composite Catalog, 21st Edition.)

For more data, circle No. E5 on Reader's Service Card, last page this issue.

Rotating Wall Scratcher

For operators who prefer to remove mud cake with a rotating type wall scratcher, Baker Oil Tools, Inc., has designed a scratcher with wires that always present a scratching point to dig in and effectively remove the mud.

The scratcher wires adjust to a wide range of clearances, and maintain an effective scratching point, even under slim hole conditions. The scratcher wires of a Baker rotating wall scratcher, mounted on 5½-inch casing, successfully attack the wall of any hole size from approximately 6 inches to 11½ inches.

Each sturdy wire is held mechanically in the double shell of the body of the scratcher and then formed into a shock absorbing spiral spring to prevent permanent distortion of the exposed portion of the wire.

The strong, double-shell scratcher body is readily tack-welded to the casing throughout the area to be cemented. Successive scratchers on a given joint of casing should be spaced 120 degrees apart horizontally around the circumference, but mounted end to end vertically, with or without overlap, as desired.

(This item supplements Baker Oil Tools, Inc. data on pages 469-600 of the Composite Catalog, 21st Edition.)

For more data, circle No. E7 on Reader's Service Card, last page this issue.

New Milling Tool Line

A new line of milling tools, known as Speedmills, has just been introduced to the industry by Kinzbach Tool Company, Inc., of Houston, after an extensive period of development and field testing.

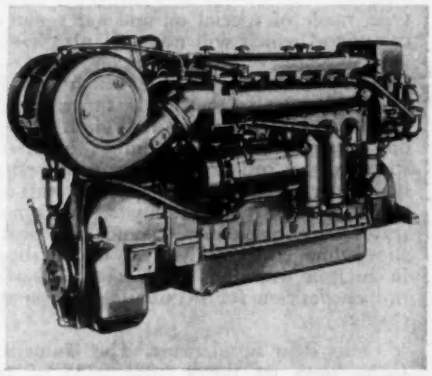
These tools incorporate an aggregate of small tungsten carbide particles imbedded in a softer metal matrix as cutting elements. The use of this aggregate permits greater design freedom in developing tools for various down-hole metal cutting requirements. Performance of these tools in metal cutting operations has been highly effective while being operated at high speeds and with comparatively heavy applications of weight. Much less care is required for their operation than is necessary with other types of milling tools.

The cutting action of Speedmills is very similar to that of a grinding wheel with new cuttings surfaces being developed continuously by particle fractures. Very small chips develop, which require less torque than the larger chips cut by continuous edge type tools. Reduced torque eliminates drill pipe wind-up with its attendant shock on the drilling string. Speedmills may be expected to cut any metal normally used in subsurface tools or equipment at relatively high rates with great flexibility in hook-up and operation.

Several types of Speedmills are currently in production and normally available from stock or on short notice. Types are available for progressive window cutting and other down-hole milling operations.

(This item supplements Kinzbach Tool Co., Inc. data on pages 2789-2808 of the Composite Catalog, 21st Edition.)

For more data, circle No. E6 on Reader's Service Card, last page this issue.



60 Foot Crewboat Diesels

George Engine Company, Inc., is pioneering in the powering of 45 to 60 foot crewboats with GM Turbopower Detroit Diesel Engines.

The specialized problem presented by offshore drilling operations is this: many types and sizes of boats are required to reach the drilling sites under the various conditions encountered in the Gulf, yet it is important that all boats be dependable and fast.

General Motors has very recently introduced their Turbopower series 71 Detroit Diesel engines. George Engine Company, supplier of GM Marine, Industrial and Petroleum diesel engines, is the first concern of its kind in the world to install and test pilot models of these engines. The outstanding feature of these engines, models 6122 T and 6123 T is that they deliver 300 shaft horsepower in a package weighing only 2552 pounds.

(This item supplements Detroit Diesel Engine Division, General Motors Corp. data on pages 1417-1423 of the Composite Catalog, 21st Edition.)

For more data, circle No. E8 on Reader's Service Card, last page this issue.

PRODUCTION

New Dual String Packer

The Guiberson Corporation, One of the Dresser Industries, announces successful completion of a series of field tests on Guiberson's new Type RD retrievable dual string packers. Available with or without hydraulic anchor, Type RD packers are designed to operate in wells of any depth. Exclusive features are an all-steel head and heat-treated alloy steel slips, dovetailed for safe, smooth operation.

The mandrel is one-piece seamless steel tubing securely keyed in all positions, allowing tubing torque in either direction. Leakage along the mandrel is prevented by seal rings made of special oil and gas resistant compound. The packing rubber is a one-piece sleeve type, made of special oil and gas resistant compound which will not vulcanize in the well.

A jay-hook type stinger which may be latched into the packer is furnished on packers with anchor and a plain stinger on packers less anchor unless otherwise specified on order. Anchor piston slips have a very large piston area and are made of heat-treated alloy steel. O ring seals prevent leakage around the piston slips which are keyed to the anchor body in such a way that teeth are always in proper position for maximum grip on the casing.

(This item supplements The Guiberson Corp. data on pages 2081-2088 of the Composite Catalog, 21st Edition.)

For more data, circle **No. E9** on Reader's Service Card, last page this issue.

Plastic Well Casing

A new lightweight, plastic well casing was announced this week by the Southwestern Plastic Pipe Company, Mineral Wells, Texas. The new well casing was developed by Southwestern engineers after extensive market research and in close cooperation with leading water well drillers and contractors.

The new casing is to be manufactured in a single dimension (o.d. 5.563-inches; i.d. 5.200-inches). Twenty foot lengths are manufactured with plain end. A coupling is furnished with each joint.

Many contractors have reported that assembling 40-foot joints before installation materially reduces the time required for actual casing. Due to its light weight, these 40-foot lengths are easy to handle.

The new material is recommended for suspension up to 300 feet. The product is not recommended as drive casing or as surface casing to be cemented in place and drilled through.

For more data, circle **No. E10** on Reader's Service Card, last page this issue.

Water Storage Method

An inexpensive new method for storing large quantities of water used in Riverfrac hydraulic fracturing treatments has been developed by Dowell Incorporated. It consists simply of a pit lined with expendable, polyethylene film.

Dowell engineers believe that this type of storage will find widespread applications in many industries. It would be valuable to any industry which needs temporary storage space for liquids.

The widespread use of fresh water fracturing treatments, using as much as 250,000 gallons of water, has created a serious water storage problem at the well site. Although steel tanks have been used, they are difficult to transport and are relatively expensive.

These pits are easily constructed. A pit is excavated by bulldozer, with the bottom sloping toward one end. A sump is dug at the point where pump truck intake lines enter the pit, so that nearly all the water can be readily pumped out.

In a recent frac treatment near Hominy, Okla., a pit 55 by 75 feet, and about eight feet deep, was dug by a bulldozer. Two men lined it with polyethylene film in about 45 minutes.

Then 2200 barrels of water was pumped into it. The cost of the 8000 square feet of film used was $400, and the cost of digging and refilling the pit was $130. The oil operator received 2200 barrels of storage for $530, which is about the rental cost for 1000 barrels of storage in steel tanks.

These storage pits may be kept for use during swabbing operations after the fracturing treatment, or refilled by a bulldozer. In some cases, operators may prefer to use the pit later for salt water storage.

Polyethylene film is flexible over a wide range of temperatures. It is resistant to mechanical damage, weathering and deterioration. The film being used is 0.003 inch thick, and is available in up to 80 by 400 feet pieces at Dowell stations throughout the U. S.

For more data, circle **No. E11** on Reader's Service Card, last page this issue.

Money Saving Rubber Balls

Small rubber balls, only ⅞ inch in diameter, are being introduced to the oil industry as a major money saver in the well fracturing and acidizing field.

They are a part of a new type of well treatment control perfected and tested by the Research and Operations division and the Pumping Service Engineering department of The Western Company, oil well servicing concern with headquarters in Midland, Texas.

Using this new method of control fracturing and acidizing, the operator now can complete jobs previously listed as multifracture operations in only one stage, no matter how many zones are to be treated, length of a single zone, or how many feet separate the perforated intervals. The new method also can be utilized in dual pay treatments.

The small spheres in reality are free-floating valves used during fracturing and acidizing treatments in both new and old producers.

Western's trade name for the new method is Perforation Ball Sealers.

The principle involved is very simple in concept. Rubber balls, designed to rigid specifications, are injected into the treating fluid, ride down the casing in the fluid stream and seat over those perforations taking fluid at the lowest pressures. The ball valves can be used at a minimum injection rate of seven barrels per minute.

As the perforations are sealed off temporarily by the balls, the treating fluid is diverted into tighter sections for a complete treatment of the entire pay section. When the treatment is complete, the balls fall to the bottom of the bore hole where they can be left, or recovered easily with a bailer.

For more data, circle **No. E12** on Reader's Service Card, last page this issue.

New Equipment Literature

For more data on New Equipment or copies of Catalogs and Literature reviewed in this issue, use the Reader's Service postcards just inside the back cover and facing the Advertisers Index. Simply circle code numbers of items desired—sign and mail card. Requests are transmitted to the manufacturer as soon as received by us for mailing of desired information directly to you.

Ultra-Violet Analysis Data

Oil base, Inc., Compton, Calif., pioneer producer of oil base muds, emulsion muds and non-fluorescent drilling fluids, have just completed a brochure on the establishment of a system to assure accuracy of long-wave ultra-violet analysis, to prevent misinterpretation of fluorescent show in cores and cuttings.

Drilling fluids that have fluorescent properties make black-light analysis of cores and cuttings incorrect and misleading. Comparison of the fluorescent properties of various crude and refined oils is shown versus the use of a non-fluorescent oil for emulsion drilling muds. Also included is a comparison in color photography of the difference between thread lubricants having both fluorescent and non-fluorescent properties. An actual copy of the study is included for your persual.

The technical information is the result of many years laboratory and field correlation of commonly used oils in drilling muds from various producing areas. Fifty-eight unretouched color photographic reproductions made under both white and black light includes visual effects of heating samples at 280° F. to show what changes occur under temperature to most refined oils.

To get a copy, circle **No. E13** on Reader's Service Card, last page this issue.

Shale Mud Brochure

A new mud which improves drilling fluid performance in troublesome shale formations has been developed and is being marketed by Magnet Cove Barium Corporation. This product, called T-8 Compound, is described in an eight-page technical bulletin, No. 81-56, published by Magnet Cove.

To get a copy, circle **No. E14** on Reader's Service Card, last page this issue.

Vertical Filing Catalog

The manufacturers of the PLAN HOLD line of vertical filing equipment have a new eight-page catalog: "The PLAN HOLD Story" showing four different methods of vertically filing blue prints, maps, etc. Included in this Catalog No. 5 is the proven Type of "S" standard Plan Hold, which can be used in various home-made racks in place of sticks, slats, etc.

Holes and other mutilations are completely eliminated with Plan Hold friction type binders made entirely of light weight aluminum. They will hold 1 to 150 sheets.

To get a copy, circle **No. E15** on Reader's Service Card, last page this issue.

"Packaged" Power Units

Davey, Paxman & Co., Ltd., has published a 20-page multi-colored catalog identified as publication Number 1478 on Paxman Oilfield Power Units. The booklet gives detailed specification, power curves and construction features of the complete line of Paxman engines ranging from 100 to 800 horsepower.

The Packaged Units are available with either fluid coupling or torque converter and feature interchangeable parts on various size units. Spare parts are plastic coated for unlimited storage duration.

To get a copy, circle **No. E16** on Reader's Service Card, last page this issue.

Optical Tooling Booklet

A 20-page illustrated booklet explaining the theory, principles and practice of optical tooling, the revolutionary new method of measuring, positioning, and aligning, is available free of charge from Charles Bruning Company, Inc.

In addition to explaining the basic theory of optical tooling and showing some of its applications, the booklet also illustrates and describes the complete line of Brunson optical tooling instruments and accessories, for which Bruning serves as exclusive national distributor.

To get a copy, circle **No. E17** on Reader's Service Card, last page this issue.

Tractor Operator's Guide

A comprehensive operator's guide for Caterpillar wheel Tractors and Scrapers has recently been published by Caterpillar Tractor Co., Peoria, Ill.

The 24-page booklet describes the proper operation of rubber-tired earthmovers in all phases of their work. In helping operators gain proficiency, the booklet is written in terms of operator benefits—easier operation and rewarding performance. Since bigger payloads and faster hauls are important to both the owner and operator, detailed tips on loading, hauling, dumping, and returning are included. Operator ease is stressed in an explanation of proper shifting and use of the scraper controls. Color pictures further explain important facts about the earthmoving cycle.

To enable an operator to quickly grasp basic service checks on his equipment, the booklet includes an easily understood checklist of important pre-operation checks.

To get a copy, circle **No. E18** on Reader's Service Card, last page this issue.

Forged Steel Unions Data

A new 8-page bulletin, U-1-56, announced by W-S Fittings Division, H. K. Porter Company, Inc., presents complete dimensional and engineering data on the complete line of W-S forged steel unions for high pressure service.

Types of unions described in the new bulletin are: 3000 pound forged steel unions, designed to AAR dimensional specifications; 2-bolt and 4-bolt flange unions in 2000 pound and 3000 pound classes; 3000 pound O-Ring flange unions; orifice unions; tab orifice unions; the W-S clamp ring unions; forged stainless steel unions; forged steel unions with bronze-to-steel and stainless-to-steel seats; and lug nut unions.

To get a copy, circle **No. E19** on Reader's Service Card, last page this issue.

2 GREAT NAMES ARE JOINED!

SEE PAGES 204-205

PERFORATE TUBING IN THE WELL

KINLEY TUBING PERFORATOR

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